GAS JOURNAL

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THE BRITISH INDUSTRIES FAIR

FOR all trade and technical journals the major annual exhibitions which come round with the regularity of the seasons present something of a problem. They are important national events; they contain items of interest to almost everyone; they cannot be ignored. And yet, inevitably, there is a large degree of repetition. At the average exhibition at least 90% of the exhibits are the same during three or more years. Should such items be deleted from a published report, and attention called only to the newer aspects and most recent innovations, or should the exhibition be reviewed in full? Sound arguments can be produced to support either viewpoint, but in the main the balance is in favour of the complete picture. There is a responsibility to readers—and to advertisers, too—and the newspaper technique is insufficient for the discerning visitor and the armchair explorer alike.

This problem of adequate coverage in relation to available news space reaches its peak with the British Industries Fair. Of the total of 1,257 exhibitors at Castle Bromwich nearly 150 are of direct or indirect interest to the gas industry. In pre-war days the total was far less and space was within reason, unlimited. Readers will remember the special *Gas Journal* supplements which increased our then formidable number of pages to a size now only within the reach of Government publications. Those carefree days are gone; every trade journal in the country is experiencing severe cramp as a result of soaring production costs. How then should the task of reviewing the B.I.F. be tackled? Well, we have tried to find the answer, and the account of the Fair which appears on later pages is designed to strike a balance between opposing requirements. In the first place, it is not a preview, which is inevitably incomplete, and cannot give a considered appreciation of the event. Secondly, our account attempts to uncover the new developments and call attention to recent trends in industrial design. Thirdly, it is as near a complete coverage of the Fair from the gas engineer's viewpoint as could be compiled. It will, we believe, be of service to our readers and will effectively reveal the striking emphasis placed upon gas at this 1950 shop window of Britain.

The *Journal* review of the Fair refers only to individual stands and individual impressions. It is, therefore, fitting that we should mention more general impressions and draw some conclusions from them. Superficially, the engineering and hardware section at Castle Bromwich looks much the same as ever. The building, although extended on several occasions, still looks like the aircraft hangar for which purpose it was built in World War I. Moreover, its camouflage form of decoration, which did not seem so strange in 1947, strikes a distinctly bizarre note in 1950; coupled with the somewhat inadequate bunting it smacks a little of the Boy Scout fête. But this is by the way; the freshness of the egg is seldom revealed by its shell.

For the gas industry this is unquestionably the most important B.I.F. since the war. It marks the welcome return of the gas section, and as a result our industry, represented here by 17 exhibitors, gives an impression of unity, character and progressive outlook. Much of the credit for this must go to the Gas Council. It is always a pleasure to give praise, but as it is our policy to do so only when the praise is deserved, it is sometimes necessary to tell home truths. Of this Gas Council exhibit, however, it can be said with all honesty that this is one of the best looking stands it has been our pleasure to see. Certainly it is immeasurably better than those which represented the industry on the last three occasions. It successfully evades the two extremes—the soulless information bureau and the ironmonger's shop. As later pages reveal, the industrial exhibits are interesting and well-chosen, while the introduction of domestic appliances gives the stand a wider appeal. The varied contributions of gas to industry are effectively stressed, and pennants bearing the names of the 12 area boards combine a reminder of State control with an impression of individualism allied to unity. It might also be added that the stand was completed on Press Day on May 5, when the E.D.A. stand resembled nothing more than a bomb site.

There is, however, another important part of the Gas Council's work which is all too seldom stressed. This is the provision of abundant handouts and publicity material which solidly backs up enterprises of this nature. There is no electrical counterpart of this service worth mentioning.

OPERATION EFFLUENT

IF sewage purification technicians are under the impression, as we fear they are, that gas engineers and others who send industrial effluents into their systems are not anxious to co-operate we hope that Mr. Philip Wedgwood's witty and energetic paper to the Eastern Association of Gas Engineers and Managers will do much to correct that impression, at any rate as far as it concerns the gas industry. There are no doubt many small gasworks where nothing is done to condition the effluent before turning it into the sewers and others where nothing more is done than with the assistance of a storage tank to regulate the outflow, generally by amicable arrangement with the sewage engineer. But this paper must do much to assure 'the other side' that in all the larger works this problem is being treated as one of urgency, as indeed is imperative, particularly where very large installations are in building or contemplation and where the gasworks effluent will form a very considerable fraction of the total industrial waste to be treated at the neighbouring sewage works.

The entertainment value of Mr. Wedgwood's paper, as they say in the film industry, is very high. His analysis of previous literature, introduced by an excerpt from Alice in Wonderland, is very spicy His comment on Dr. Key's very excellent book is a case in point; it has even been quoted as authoritative evidence against Mr. Wedgwood himself. We looked it over again after reading this paper and while we agree with Mr. Wedgwood's contention that it might very well have been brought up to date in the recent re-issue and even extended to other effluents than ammonia and ammoniacal liquors we cannot find any great divergence in *principle* between Dr. Key and Mr. Wedgwood. And after all the function of a text-book is to set out principles with such examples as may illustrate them.

But Mr. Wedgwood does well in pointing out in his pungent way what must be done to reduce, as far as this can be done at the points of origin, those constituents and properties of liquid effluent which are inimical to the process of sewage purification. There is his insistence on the necessity for accurate knowledge of the volume and composition of the mixed finished liquor—a point which he is most anxious to press. He rubs in the necessity of keeping oxygen away from the liquor which, apart from attention to leakages, involves the admission of air for revivification at the purifiers and not at the exhausters. He would like ammonia to purifiers to be *nil*. He stresses the deleterious effect of excess steam to vertical retorts and the importance of keeping the volume of virgin liquor to the minimum. He seems to censure Dr. Key for omitting reference to the effluent from water gas plant and he sums up, briefly, that all waste waters of the works should, preferably, be brought together into one effluent tank in which solids can be settled and oil separated before the cleared liquid is allowed to flow into the sewer.

The fact seems to emerge that treatment of effluents of all kinds prior to discharge to the sewers must henceforth be reckoned with in estimates of cost of manufacture. The extent of the treatment will vary according to the circumstance, according to the proportion of gasworks effluent to the total intake of the sewage works. The sort of attitude to be deprecated is that decisions for or against any particular type of carbonising plant should be weighted by any other consideration than that of cost even where there is a difficulty in disposing of the liquor effluent, a difficulty which we suggested can be always overcome at a cost which can quite fairly be included in the balance. We are, besides, quite sure that Mr. Wedgwood's hope will be realised that in course of time we shall be able to take down that fence (the symbolical division between us and the sewage works) so that we can all work together in harmony.

In the meantime we could not more agree with him that we should do something about using our ammonia. We have ourselves called attention to methods by which concentrated ammonia liquor can be, and is being, applied direct to the fertilisation of arable land. We might even examine again, with Mr. Wedgwood, the question of giving it away to farmers.

EVALUATION OF COAL

THE Manchester District Association of Gas Engineers, at its 80th annual meeting, formally adopted the necessary resolutions by which it becomes a District Section of the Institution of Gas Engineers. This step had been so fully discussed on previous occasions that apart from the blessing pronounced upon it by one who must now be the father of the Association, Mr. C. S. Shapley, there seemed nothing further to be said. The murmur of approval which ran through the meeting clearly indicated a sense of relief that this wise and necessary step had at last been taken. Very generously the Yorkshire members, through the voice of Mr. G. E. Currier, expressed their whole-hearted agreement that 'Manchester District' should still be the geographical description of the new Section. The new President, Mr. N. G. Appleyard, of Leeds, was very warmly received; and a sign of the new dispensation was the cordial invitation of the Chairman of the North Eastern Area Board, Dr. R. S. Edwards, extended to the Association to visit the Leeds undertaking for the usual summer President's Day.

The Presidential Address, published in the *Journal* of May 3, consisted of three distinct parts; some observations on the evaluation of coal in relation to carbonisation, a description of the organisation of the accountancy department of the Leeds group of undertakings, and some general remarks on the policy of the North Eastern Gas Board in relation to the personnel of its constituent undertakings. The problem of the rational evaluation of coals in relation to carbonisation is one which has so far defied solution, if by that is meant the prediction, from the analysis, chemical and physical, of a small sample, of results to be expected in practice. In regard, however, to the main varieties of what may be called 'standard' gas coals available in this country the position is not hopeless. Quoting 'King's Manual,' p. 16, 'The graphs reproduced by the British Gas Federation Post-War Planning Sub-Committee on Manufacture and Distribution of Gas provide a ready means of assessing the results of operation and of comparing the results obtained in various types of plant.' These graphs might well serve as the basis

of 'the assessment of carbonising results, one works with another' for which Mr. Appleyard is seeking. Considerable care, however, would have to be exercised in making corrections for variations in the analysis even of these standard coals. Correction for ash content, within limits, would be purely arithmetical, but everyone would agree, we think, with the President in his remark that volatile matter and gaseous thermal yield do not appear to have any fixed relationship. Experience seems to show that 'standard' results are obtained with each of the coals as classified by the P.W.P. Committee so long as the volatile matter shown in the proximate analysis is within a point or two either side of the 'standard' figure. If the variation is more marked it would appear better to treat the coal as a new variety. And here we come to test plants, large and small.

There is no doubt that valuable information has been obtained from investigations carried out in small scale test plant, but the blunt fact remains that no one has found a constant by which gas-making results obtained in such apparatus can be multiplied to give the results realised in full-scale practice. Nor is this surprising since the carbonising conditions are, of course, fundamentally different in the two types of plant. But here a curious circumstance may be remarked. There must be several installations of carbonising plant, even in this country, wherein one retort or one unit has been so arranged and equipped with auxiliary plant that it can be isolated and used as a test plant. Such a test plant could give results representing exactly those obtainable in full scale practice. Of course, a much larger sample of the new variety of coal is required than in the usual 1/100th ton test plant, but we suggest that 20 tons is not an unpractical sample for a new variety of any potential importance. The circumstance to be remarked is that one cannot recollect the publication of any considerable amount of information obtained in these full scale test plants, or even of an account of their use in practice. If one or more of the undertakings in possession of these plants would report on their use over an extended period and a fairly wide range of coals they would be making a valuable contribution to the data of carbonising practice.

Mr. Appleyard touched on a number of problems confronting the carboniser, but none so important as that arising from the too great day-to-day variety in the coals sent to the one works. The attention of the coal industry has been drawn to this point. Plant can be designed to suit almost any class of coal within reason, but it is not reasonable to expect it to be operated at its highest efficiency when the properties and size of the coal are abruptly and without notice altered. Variation in size, particularly in the continuous vertical, calls for adjustment of throughput, an adjustment which may require some hours before it is brought into line with requirements. If the size is to be kept reasonably constant over a fair period this presents no great difficulty, but when small coal follows large coal difficulties as serious as hanging charges may arise. In short, what the gas industry requires of the coal industry is supplies constant in size and properties or at any rate fair notice of any changes so that plant adjustments may be made to meet them. Short of the complete elimination of excessive variety, judicious allocation, as may be possible when the area boards have reached maturity, would undoubtedly help.

The story of the transfer of financial and statistical control from the several municipal and other authorities, former owners of the constituent undertakings, to the central organisation of the group will, no doubt, be paralleled in many other instances. It is satisfactory that with goodwill and tact on both sides the transfer at Leeds has been smoothly effected. Mr. Appleyard is satisfied with the broad-minded policy of his area board. His 'general remarks' will meet with universal approval throughout the industry. The voice of the engineer in charge will always be heard, and heeded, in the conduct of his own undertaking. That of the whole body of engineers will be effective in its influence of policy in general when it is heard in their district and national institutions.

JUNIORS' TRAVELLING EXPENSES

In the *Journal* of March 8 we commented in these columns on a joint meeting of the Eastern and Western Districts of the Scottish Junior Gas Association at Falkirk which was addressed by the Chairman of the Scottish Gas Board, Sir Andrew Clow. At that meeting the matter of payment of expenses for juniors to attend association meetings was raised, and Sir Andrew made it clear that he wanted to encourage attendances at such meetings and was in favour of doing what was legitimate regarding expenses entailed. Following the meeting the question was re-opened at board level and it was agreed to pay the expenses of the juniors for all their meetings in Scotland. The Scottish Gas Board has certainly shown a generous attitude in this respect, but we maintain the view we expressed in the *Journal* of March 8 that the junior associations in general cram too many meetings into their sessions and that such a crowded programme is neither necessary nor desirable. We look upon the allowance of juniors' expenses as an investment and a stimulus towards a better educated and more proficient personnel in the gas industry; but the result must be judged by the keenness of the junior and his striving to benefit his undertaking as well as himself.

'SEGAS JOURNAL'

We have just received No. 1 of Vol. 1 of the *Segas Journal*, the magazine, which is to be published monthly, of the South Eastern Gas Board. The Editor is Mr. A. Douglas Lacey, the Assistant Editor Harry Lewis, both of whom have had much experience in the work involved in such a production. Mr. Lacey was formerly Editor of the *Co-partnership Journal* (South Metropolitan Gas Company), and Mr. Lewis was Editor of the *Croydon Co-partner* (Croydon Gas Company). The *Segas Journal* incorporates these pre-nationalisation magazines and also the *Wandgas Magazine* (Wandsworth and District Gas Company), the *Co-partnership Magazine* (Brighton, Hove, and Worthing Gas Company), and *Reflections* (Eastbourne Gas Company). The new paper covers an area of 3,300 square miles, and the first issue covers, too, the activities of the divisions of the South Eastern Gas Board since the beginning of 1950. It runs to a matter of 84 octavo pages and is packed with news from the board's six divisions and from the Chemical Products Department. We congratulate the Editors on the way they have organised this area board magazine, the second of its kind—the first being *Emgas* (East Midlands)—and we can appreciate the amount of work which has been put into the first number. We shall miss the individual character of the former co-partnership magazines merged in the *Segas Journal*, but within the covers of the latter employees of the board at Woking will know what their confrères are doing at Dover and those at Gravesend will be able to glimpse the activities of their opposite numbers at, say, Seaford. We shall look forward to the June issue, which will more truly represent a monthly magazine of its type in the present era of nationalisation.

SCIENTIFIC RESOURCES

THE House of Commons debated on May 6 the first Private Member's motion for 12 years. Mr. M. Philips Price, M.P. for Gloucestershire West, moved that 'in the opinion of this House, there should be the fullest development and utilisation of Britain's exceptional scientific resources and manpower, with a view to ensuring effective progress in the development of our industry, agriculture and colonies, and a material improvement of our economic position in the world.' The resultant debate was of necessity non-party and in the wide range of subjects covered took the form of questions and suggestions to Mr. Herbert Morrison, the Lord President of the Council. Three major doubts were voiced by Mr. Price and following speakers. The first was whether private industry was making full use of the work done in research stations or whether it was sometimes using it to improve its financial position, without passing on the benefits to consumers. The need for a technological university was, of course, once more expressed, and the final question concerned the degree of co-operation between the three research stations connected with fuel—the Fuel Research Station, the Coal Utilisation Research Association, and the new laboratories of the National Coal Board. In reply, Mr. Morrison adopted a note of quiet optimism. Research associations, he said, which are the creatures of private enterprise, in co-operation with the Department of Scientific and Industrial Research, did show that private enterprise was increasingly taking an interest in the problems of science. In regard to overlapping in fuel research he did not think that there was much danger there. The Minister was responsible for the co-ordination of fuel research, assisted by his own Scientific Advisory Council, on which the Chairman of the Fuel Research Board of the D.S.I.R., the N.C.B., and the other nationalised fuel industries were represented. He could assure the House that the question of a technological university comparable with the Massachusetts Institute of Technology was not being neglected, and if further action did not follow as quickly as it might be hoped it would be due to technical difficulties and not to any failure by the Government to appreciate the importance and urgency of the task.

BUILDING WORKING PARTY

APPOINTED by the Minister of Works in July, 1948, to enquire into the organisation and efficiency of building operations, the position of the professions in relation thereto, arrangements for financing operations, and types of contract in general use, the Working Party on Building Operations, under the Chairmanship of Sir Thomas W. Phillips, G.B.E., K.C.B., has presented its report, based on evidence received from some 120 organisations, including the Institution of Gas Engineers. It is noted that the combined effect of lower productivity, higher wage rates, and higher cost of materials was that building costs generally throughout 1948 and 1949 were about two and a half times those of 1939. The fall in the level of productive efficiency to about two-thirds of its pre-war level in 1946-47 and about three-quarters in 1948 was due to the reduction in the building labour force during the war; its rapid increase to almost pre-war level immediately afterwards, dislocation of management during the war, the launching of a building programme greatly in excess of existing resources, the subsequent changes in the programme, delays and uncertainties owing to shortages and controls, compulsory use of untried materials, and the inflationary condition of the country's economy. Two factors affecting efficiency are 'full employment'—entailing the absence of a reserve of unemployed labour, to which the industry must adjust itself—and planning controls; 'a determined effort,' says the report, 'must be made to remedy' the circumstances in which arrangements for issue of licences and permits cause delays and uncertainties. To raise productive efficiency above its pre-war level all concerned in building should co-operate fully in everything that helps to improve efficiency and to extend the advantageous use of the appliances, methods, and materials which scientific and technical advances place at their disposal; building operations of any size must be completely pre-planned; and building research must be efficiently organised and the results made widely known. The Working Party considers incentive payments are essential if output is to be adequately increased; more economical use of building materials is essential if costs are to be lowered; and greater use should be made of British Standard specifications. On the question of research, the report urges that in the selection of subjects representatives of the industry should be fully consulted and given opportunities for making suggestions. Conduct of research should be carried out in the main by organisations of primarily scientific character and effective arrangements should be made to present research results so that they can be readily applied in practice.

Personal

Mr. **J. Briggs** retired on April 1 from his position as Manager of the Edenbridge and Westerham undertakings of the South Eastern Gas Board.

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Mr. **Ernest W. Apsey,** ASSOC.M.INST.GAS E., formerly Industrial Gas Engineer in the Bristol Sub-Division, South Western Gas Board, has been appointed Industrial Gas Engineer to the Alliance and Dublin Consumers' Gas Company.

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Dr. **J. Cameron Smail,** Principal Emeritus of the Heriot-Watt College, Edinburgh, has been presented with a bronze medal by the Edinburgh Chamber of Commerce to commemorate his election as an Honorary Member of the Chamber. Dr. Smail is the only Honorary Member on the roll at present.

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Mr. **John D. Baxendale,** Distribution Engineer of the Bingley and Shipley districts, North Eastern Gas Board, for the last two months, and former Deputy Engineer and Manager of the Bingley undertaking, has been appointed District Engineer and Manager of the combined Yeadon and Guiseley districts and Calverley and Horsforth districts of the Leeds Group. Mr. Baxendale, who takes up his appointment on June 1, was educated at Bingley Grammar School. He served in the R.A.F. for six years, attaining the rank of acting-Squadron Leader.

Diary

May 17.—London and Southern Junior Gas Association: Visit to Shell Refineries, Shell Haven, Essex.

May 19.—Wales and Monmouthshire Association of Gas Engineers and Managers: 45th Annual Meeting, Little Theatre, Tenby, 10.30 a.m. Presidential Address of Darrell W. Rees, M.B.E. Official luncheon, Royal Gate House Hotel, 1 p.m. Short technical papers followed by discussions, 2.30 p.m.

May 19.—Scottish Junior Gas Association (Western District): Visit to Newton Chambers & Co., Ltd., Thorncliffe, Sheffield.

May 23.—Southern Association of Gas Engineers and Managers: Spring General Meeting. 'Forty Years of Reinforced Concrete with Special Reference to Recent Developments,' E. O. Rose (Divisional Engineer) and W. T. Gedge (Divisional Constructional Engineer, Tottenham Division, Eastern Gas Board. Connaught Rooms, London.

May 24.—Western Junior Gas Association: Visit to works of G. Waller & Son, Ltd., Stroud.

May 25.—Midland Association of Gas Engineers and Managers: Annual and Spring Meeting, Leicester. Business Meeting and Luncheon, Grand Hotel. 11 a.m. Visit to Aylestone Road Works, 3 p.m.

May 27.—London and Southern Junior Gas Association: Visit to Mogden Sewage Purification Works, Isleworth.

May 30.—Southern Association of Gas Engineers and Managers (Eastern District): County Meeting. Luncheon at Town Hall, Catford, 12.30, followed by visit to Sydenham Works of the South Eastern Gas Board.

May 31.—Eastern Junior Gas Association: Annual General Meeting and visit to Bedford Gasworks.

June 2.—London and Southern Junior Gas Association: Annual General Meeting. Lecture Theatre, 178/180, Edgware Road, W.2. 7 p.m.

June 5-9.—Institution of Gas Engineers: Annual General Meeting, Bournemouth. For detailed programme see *Journal* of May 10 (p. 369).

Co-operation in Consumer Service

Tribute to North Thames Consultative Council

A MEETING of the North Thames Gas Consultative Council was held on April 27 at St. Ermin's Hotel, Westminster, S.W.1, the Chairman, Councillor Edwin Bayliss, J.P., presiding. The meeting was addressed by Mr. S. G. Aberdein, Commercial Manager of the North Thames Gas Board, who gave a report on developments on the sales and service side of the board's work since nationalisation and a summary of future policy.

In welcoming Mr. Aberdein the **Chairman** said that under the Gas Act an area board was required to present its plans for immediate and future development to the consultative council. Some councils had thought it better to have such plans submitted in writing; they on the other hand had preferred to hear them by word of mouth from chief officers of the board. In this way, it was felt, more could be learned and opportunities were provided for cross-questioning.

Mr. **Aberdein** said that in view of the fact that Mr. Michael Milne-Watson, their Chairman, had already explained in broad outline the board's organisation and that they had a detailed picture in the North Thames booklet, he did not propose to go into further organisational detail. He prefaced his report with a simple explanation of the main responsibilities of the commercial side of the board, and emphasised that one of the most important factors in the success of their business was the provision of a first class consumer service at an economic cost. One of the most important pointers to whether this success was being achieved was the questions raised by the council with the board on behalf of bodies of consumers or individual consumers. He quoted examples of some of the contributions which the council had made. These included suggestions on appliance service facilities and Saturday opening of showrooms, and information on meter rents. Showrooms were to be opened as an experiment at Kilburn, Harlesden, Camden Town, and Hounslow, on the following Saturday, and action which was to be taken on the first suggestion would be described in a later section of his report.

Customer Complaints

Another valuable indication was customer complaints. In the first 11 months of nationalisation only 145 out of nearly 2 mill. consumers wrote either to the Minister, their local M.P., the consultative council, or to the chief office of the board complaining of one aspect or another of the service. The subjects for complaint comprised: Appliance complaints, 41; delay in completing orders, 49; disputed charges and miscellaneous, 34; defective supplies, 9; more serious complaints and criticisms of policy, 12. It was possible, Mr. Aberdein continued, that their customers had given up the unequal struggle, but in view of the keen public interest taken in nationalised industries, this seemed a remote possibility.

There was also much to be learned about the effectiveness of their service from the trends of the various classes of business transacted in the showrooms. The figures for the Gas Light and South-end Districts for the years 1947/49 showed a substantial increase in new business; in fact, over double the number of appliance enquiries were booked in 1949 in comparison with 1947 and on the customer appliance and coke complaint side there was a progressive and marked decrease.

Salesmen's Circles had now been reconstituted throughout the board's area, and opportunity was provided at these meetings for open discussion between the management and the men directly in touch with consumers. Much valuable information as to consumer requirements and reactions was gained in this way, as well as providing a means of keeping salesmen in touch with new developments and latest methods.

Fruits of Integration

Mr. Aberdein then described some of the advantages which had accrued from integration following nationalisation. Calorific value had been standardised throughout the area, permitting complete interchangeability of appliances and the transfer of gas through the Gas Light grid to other districts of the board. Uniform cash and hire purchase prices and terms had been established, together with uniform hire rates for new and re-issued appliances. Central bulk buying enabled the most favourable prices to be obtained. All appliances known to be installed on the district had been graded into three categories—current, non-current, and obsolete—to enable a better service to be given. Thus a fitter knew which types of appliance were obsolete, and was in a position to report back when a defect occurred; a district representative could then call and offer an alternative appliance. In regard to material charges, standard prices had also been adopted for lighting fittings, stove parts, and for material generally.

Standard fixing-to-point charges had been introduced, but some variation in charges for other types of work would continue, at least for the present, because of differences in labour rates and overhead costs. The board's home service organisation, which was playing an increasingly important part in customer contact work, was now operating in all parts of the board's area, and made in 1949 nearly 20,000 visits to customers in their own homes.

The service organisation had as its aim the standardisation of appliance service throughout the area, taking account of the various appliances already installed in each district, and any special local factors. This was not possible at present with the existing labour force in some districts; recruitment of suitable workmen would not be easy and it would take time to train them to the high standards required.

Mr. Aberdein continued: 'The Council suggested in January last that we should publicise the facilities available. As I have already mentioned, we have acted on the suggestion and it is proposed to distribute a notice to consumers in the near future calling attention to the facilities available for overhauling gas fires.' Publicity for other types of appliances would follow, but caution had to be exercised to avoid a great inrush of work which would cause embarrassment in one or two districts.

In some areas the demand for gas was outstripping existing mains capacity, and the board had already approved schemes for reinforcement in those areas, their implementation being dependent on the labour and material position. Additionally, they were carrying out a systematic examination of consumers' premises in such areas of the board. The trouble was purely local in many cases.

In regard to the future, Mr. Aberdein said that the most important question was undoubtedly gas tariffs. These divided themselves into three parts—maximum charges for re-sale of gas, the pre-payment supplement, and gas tariffs generally. It was hoped to comply very shortly with the requirements of the Gas Act, whereby maximum prices at which gas supplied may be re-sold will be fixed. Mr. Aberdein added that once such maximum charges had been established, any dispute would then be a matter between the landlord and his tenant. The problem of prepayment supplement was involved, but the board was considering various alternatives to the present system under which the great majority of slot consumers were charged according to the quantities of gas supplied through the meter. Their objective was to relate the charge more directly to the service given. Progress was being made with the complex problem of a revision of gas tariffs.

83% Prefer Gas

On the industrial and domestic side, the high standard of service given by the Gas Light team of specialists was being extended to all districts. Approximately 76,300 new and converted dwellings had been completed and occupied since the war in the board's area, and five out of six of the tenants had chosen gas for cooking. Of the 47,400 new houses erected in the board's area since the war, 40% were equipped with modern smokeless fuel grates with gas ignition.

In the maintenance and development of the existing load, 70,000 black cookers were replaced during the years 1947-49, and a further replacement of 70,000 had been planned for this year. The total budget for new and re-conditioned enamelled cookers for 1950 was 171,000, and it was hoped to begin in the near future production of the board's new 'Popular' cooker, designed primarily for prepayment consumers and incorporating many new features, which would mark an outstanding advance in cooker design.

There was no doubt, he added, that

(*Continued at foot of p. 444*)

West Midlands Meets Increasing Load

Progress Report Presented to Consultative Council

FIGURES showing records of output and information regarding large-scale development work were given at a meeting of the West Midlands Gas Consultative Council, held at Birmingham gas offices on April 24. An interesting feature of the business was an informative report by the Chairman of the West Midlands Gas Board, Mr. G. le B. Diamond, on the work of the board and financial matters, from which it appeared that the new taxation on petrol and commercial vehicles would cost the board £47,000 a year. Reference to this and further aspects of Mr. Diamond's statement was made in the editorial comments of the *Journal* on May 3.

Two subjects occupied some attention; one referred to liquor disposal at Redditch, which is a considerable problem there; and the other showed how the reconstruction scheme at the Walsall (Pleck) works was likely to progress more quickly on account of an urgent change in the original arrangements.

Mr. **H. J. Paramore,** Chairman of the Redditch Sewage Committee, indicated some anxiety in dealing with liquor disposal, which is a more difficult problem there, it was explained, on account of the consumption of gas being 60% industrial and domestic only 40%.

Effluent Problem

Mr. **Diamond** went into the technicalities of the matter, and explained that the problem on which the experts differed was the particular acids or constituents of tar which killed the sewage bacteria. It was not a new problem, and the experts had been closely investigating the question for the last 20 years or so.

However, while Mr. Paramore mentioned the possible provision of three electric detarrers, Mr. Diamond said the installation of one unit would certainly alleviate the situation, and this was to be proceeded with. Mr. Paramore expressed satisfaction that he could report back that something was being done, and that the board had this Redditch matter constantly in mind.

Mr. **Diamond** stated that research was continuing on this subject; the difficulty was to ascertain what were the really destructive constituents of liquor, and there was ground for believing that other trade wastes complicated the subject. It might be that gasworks liquor was often blamed for the destruction of bacterial life in the filter beds when perhaps other things were the cause.

Mr. **W. Kelley** mentioned that there was a strong feeling in the Walsall district regarding the shortage of gas supplies. Just before the nationalisation of the industry Walsall Corporation had a scheme of extensions which would run into seven figures and would double the output, and they were given to understand that they would be able to meet the greater part of the demand by 1952-3. They were assured by the Woodall-Duckham Company, who had the contract, that this was the date they thought the plant would be in operation. However, they in Walsall were now informed that the demand was not likely to be met until 1955-6, and there was in consequence some consternation in Walsall industrial circles. He therefore suggested that the Chairman of the gas board might enlighten them by giving the facts.

Mr. **Diamond** said he had dealt with this matter in his statement, which he proposed to give later, and which showed that the new position was much better than Mr. Kelley's enquirers feared. The facts were that the Walsall Corporation had placed an order with the Woodall-Duckham Company for a retort house and certain ancillary plant, and when the gas board took over they looked into all new projects in the area ordered by the previous owners of undertakings. They came to the conclusion that the Walsall position was even more serious than when the Walsall Corporation had dealt with the matter. Hence he started making enquiries to see whether any carbonising plant ordered for another area board and which owing to a change of circumstances through nationalisation might not be used, could be obtained. Fortunately he found that a 6 mill. cu.ft. output plant of the same size as that ordered by Walsall had been ordered in 1945 for the Romford gas undertaking, and he was able to obtain this plant from the North Thames Gas Board. This particular plant had been largely fabricated, and deliveries of steel were actually lying on the Walsall site today. The position was that while the plant contracted for at Walsall could not be on the site for 1952-3 because of the steel position, and nothing could be done to expedite it, the board had secured another plant for Walsall more speedily than the Corporation could have done; and had it not been for nationalisation the removal of this plant from Romford to Walsall would never have been sanctioned.

Development Work

Mr. **Kelley** expressed his thanks to Mr. Diamond for this information, as he was due to inform the people concerned of the position; and he specially noted Mr. Diamond's claim in relation to the date given when the contract was placed by the Corporation. In this connection Mr. Diamond pointed out that they could not place absolute reliance on the date placed before them by a contractor, however high his position, because the contractor did not know what the future would bring forth owing to the shortage of materials and labour.

Councillor **W. H. Malcolm** presented a long and detailed report on development work in progress or completed since last August, and also a report on development work authorised for commencement by the board during the first quarter of the year. He stated that the total estimated cost of these various works was £1,865,013; and that the increases in daily capacity, which new carbonising plant covered by these developments would make possible, totalled 537,000 cu.ft., while the additional water or producer gas plant should yield a further 13,850,000 cu.ft. There were 53 projects for main laying totalling 101,768 yd., roughly 58 miles. A gasholder at Worcester would have a capacity of 4 mill. cu.ft.; this was in addition to new gasholders at Stafford, Coventry, and Hereford—the one at Coventry for 6 mill. cu.ft. A great amount of plant was being erected and much work being done, but it would take time to get all the steel required. It would be interesting to local authorities and committees to see what was planned and happening in their particular areas. The holder at Worcester had taken nearly 12 months of negotiations between the gas board, the Ministry and the local authority and the ultimate decision to place it in the Perry Wood district was satisfactory to the local authority and everybody else concerned. The Chairman added that fuel oil would cost £85,000 extra owing to devaluation.

Water Gas Plant

Mr. **C. W. Parks** (Willerhall), commenting on the disparity of new capacity between coal gas and water gas, asked why the board was erecting the latter plant to a much greater extent, seeing that carburetted water gas was the more expensive.

Mr. **Diamond** explained that it was all a question of balance, and of getting the plant. Water gas plant used appreciably less material than carbonising plant, and that was why they were investigating every possibility in the project for Birmingham, because Birmingham could stand water gas to a much larger extent whereas Redditch could not stand more than was allowed for.

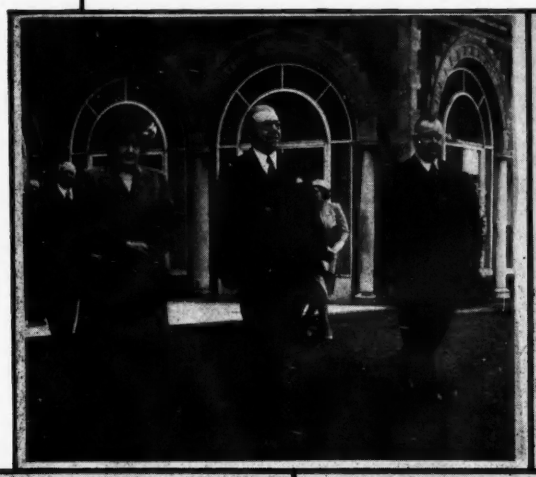
Mr. **Parks** wondered whether the industry had any priority.

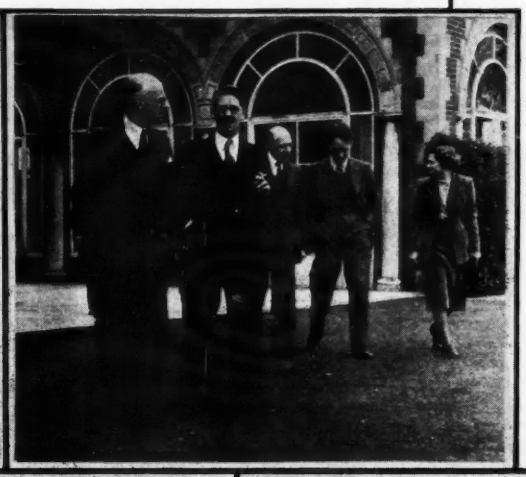
Mr. **Diamond** replied that apart from this, the board 'had to get what it can," and at the same time keep an overall balance—a certain percentage of water gas for the best use of town gas. The industry had to wait a much longer time for vertical carbonising plant compared with water gas plant, which they could get in two years. Mr. Diamond also mentioned the gas coal supply position, which was difficult enough, and asked members to visualise the situation if, having put down new carbonising plant instead of water gas plant, these difficulties increased.

Mr. **W. T. Prince** (Nuneaton) stated that the local authority had received a spate of enquiries by firms anxious to begin manufacturing in his district; quite a number of them would be users of gas. In view of the developments at Coventry, he enquired whether they could

(Continued on p. 444)

Eastern Association Meeting, May 5





WEST MIDLANDS CONSULTATIVE — continued from p. 442.

anticipate an increase in supplies in the near future.

Mr. **Diamond** promised to give information on the subject later.

The **Chairman** intimated that many complaints and enquiries were received which were all filed and gone into, and answers sent to the persons concerned. He quoted several examples.

Daily and weekly records of peak outputs of gas during the winter were submitted for 12 undertakings in the area serving industrial districts. The four leading centres were as follows, the respective all-time records, as Mr. Diamond put it, applying to the day and week mentioned: Birmingham, 101,487,000 cu.ft., Jan. 26; 631,677,000, week ending Jan. 28. Stoke-on-Trent, 22,286,000, Feb. 6; 150,109,000, Jan. 28. Coventry, 20,900,000, Jan. 30; 130,000,000, Jan. 29. Wolverhampton, 11,031,000, Dec. 12; 68,044,000, Dec. 17.

The record week's output for the remainder was: Smethwick, 37,694,000; Dudley, 31,658,000; Walsall, 30,974,000; West Bromwich, 26,802,000; Bilston, 26,482,000; Redditch 24,522,000; Stourbridge, 21,616,000; Oldbury 19,462,000. All for the same week as Birmingham except Dudley (ending Feb. 1) and Bilston (ending Jan. 29).

Mr. **H. J. Paramore** said it was remarkable as far as Redditch was concerned, because a big factory engaged on alloy metals had gone over to oil (following war production on gas fuel), though there were dozens of small undertakings continuing its use.

The **Chairman** observed: 'In all the places I have visited there is a tremendous demand for gas. This demand is extraordinary, and I do not know how the gas board get over it. Both in the complaints and through the enquiries from every quarter we can say that industry wants more and more gas. It is a wonderful revolution compared with the old days when gas was not considered anywhere near electricity.'

Work of the Board

Mr. **Diamond** gave a report to the council containing figures illustrative of the work of the board. He said that in consequence of the shortfall of coal on the estimated budgets agreed by the Ministry the total deficiency to date was 18,500 tons. In a few places the stocks had fallen to a degree which gave rise to some anxiety but there was complete co-operation between the National Coal Board, the coal factors, and the board's coal department, and the situation was being carefully watched.

The total coal carbonised for the financial year ended March 31 amounted to 2,944,000 tons, an increase of 0.3% on the corresponding period in the previous year. The total coal carbonised since vesting day amounted to 2,781,400 tons, which was 0.1% over the amount carbonised for the same period in the previous year.

Gas output during the financial year ended March 31 allowing for an adjustment for South Staffordshire Mond Gas to an equivalent of 450 B.Th.U. was 63,640,112,000 cu.ft., an increase of 1,509,212,000 cu.ft. and a percentage increase of 2.4 over the previous year.

The turnover of money, including capital items during the year, would be of the order of £25 mill. It was anticipated that the first year's working of the board would show neither a profit nor a loss after charging all outgoings properly chargeable to revenue account.

Hitherto the control and regulation of coke marketing had been in the hands of a voluntary body, the Midland Counties Coke Association in conjunction with the Ministry of Fuel and Power. Consultation had taken place between the East and West Midlands Gas Boards and it had been resolved to liquidate the joint association and to set up a separate coke organisation for each board. The West Midlands coke department had been formed and was staffed by officers from the old association at King Edward House, Birmingham.

There was every reason to think that the new arrangements would be entirely satisfactory, but the board were well aware of deficiencies in equipment and methods of coke marketing which existed among the undertakings inherited on vesting day and they were engaged in planning the provision of better equipment for the grading and handling of coke. The shortage of material and the capital cut would, however, preclude any material improvement for some years.

Commercial Policy

The board's unified commercial policy, which was outlined at a previous meeting of the consultative council, had now been implemented and new terms for hire purchase and prices had been displayed in all showrooms from April 1. Attractive leaflets and price cards giving indication of the terms were freely displayed.

It had already been reported to the Council that the contract for a complete 6-mill. cu.ft. per day carbonising unit, not required in North Thames area, was transferred to Walsall early in the year. Many hundreds of tons of steel for the new unit had already been delivered and it was anticipated that the contractor would commence work about the end of June. The general difficulties obtaining with all large contracts of this nature prevailed at Walsall and it was likely to be three or four years before the unit was gas making. Nevertheless the advantage gained by obtaining this unit already fabricated was great and it would be in production long before the original carbonising plant which was ordered by the Walsall Corporation.

Protest on Petrol Tax

Mr. **H. Baker** (Secretary, Birmingham Trades Council) drew attention to Mr. Diamond's figures of extra cost on petrol and vehicles due to the new budget taxation of some £47,000. A suggestion might eventually come as a result of this and requests for higher wages that the price of gas should be increased. He did not know whether they could make a protest, and he did not wish to advance any political assignment, but something ought to be done.

Mr. **Prince** thought that as representing the public they should voice their opinion, remarking in support that the T.U.C. had agreed to a wage freezing policy. They should bring what pressure they could to bear on the Government.

Councillor **Malcolm** said they were neither a political nor a commercial body and he hardly thought it would be right for them to pass any resolution. The Chancellor was well aware of the position, and in advising that it was better to leave the matter for the time being he pointed out that local authorities and commercial and industrial interests directly concerned would no doubt raise their voices against these taxes.

Before the close Mr. **Diamond** explained the layout of the Walsall gasworks when reconstruction has taken place—a model was shown on the centre table. He mentioned that this work had to be done while output was maintained and the existing plant kept in operation. The installation would double the present capacity to 12 mill. cu.ft. per day.

NORTH THAMES CONSULTATIVE — continued from p. 441.

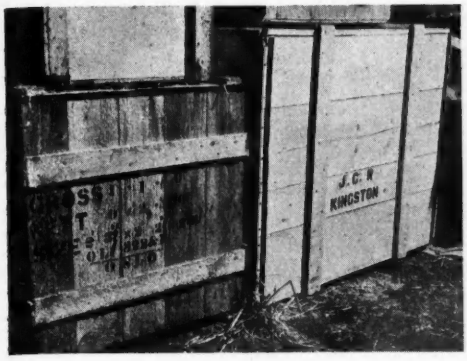
water heating constituted a typically good load. There was a big field open to them, with one reservation—purchase tax, which was seriously retarding this business. Gas refrigerators from one of several new manufacturers who had recently entered the field were at present on home test on the district and they were expecting some more from another new manufacturer.

The **Chairman** expressed the council's appreciation to Mr. Aberdein for a most wide and comprehensive review.

In conclusion, it was reported by the Chairman that the board had approved the expenditure of £27,000 in extending mains to afford a supply of gas to certain parishes in the Cookham (Berks) Rural District. He also said that the General Post Office had intimated that they were unable to display in local post offices the council's poster containing details of members and functions, giving lack of space as their reason. The Ministry of Fuel and Power had agreed to give assistance in the matter, and a letter would be sent to the Minister asking that the Postmaster-General should be approached to review the decision.

In conclusion, the council resolved to ask the North Thames Gas Board to make representations to the appropriate authority for the removal of purchase tax on domestic gas appliances.

Coal Output.—During the week ended May 6 output from the mines and opencast working totalled 4,211,700 tons, against 4,396,000 tons in the previous week. Manpower in the week ended April 29 declined by 200, including 100 face workers, to 701,600. Gas available at gasworks in the week ended April 30 amounted to 10,941.8 mill. cu.ft., compared with 10,630.8 mill. in the week before. Electricity sent out for public supply totalled 926.9 mill. units against 974.8 mill in the same period.



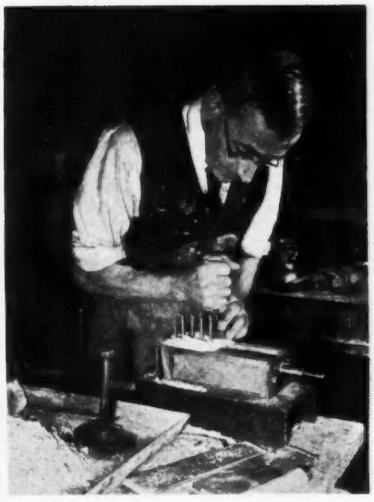
Refractory bricks manufactured by Radiant Heating, Ltd., are creating considerable interest overseas. The photographs on this page, taken by our Staff Photographer, may not reveal the secret of manufacture, but they do, in our view, provide excellent studies of the skilled workmen who have been with the firm for periods up to 40 years.

Efficiency for Export

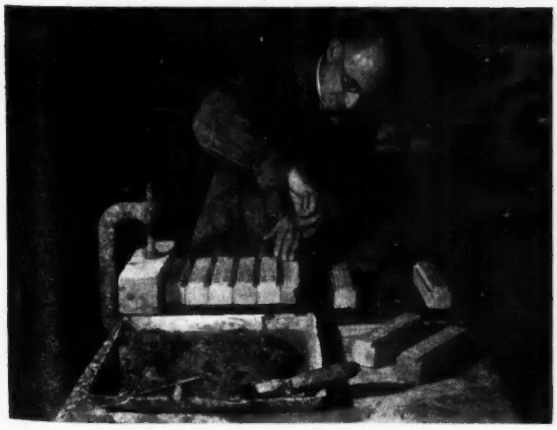
THE British Industries Fair has once more proved that gas appliance manufacturers are alive to the needs of industry both at home and abroad. One of the most interesting exhibits this year was shown by Radiant Heating, Ltd., in the form of a high-speed conveyor oven suitable for paint drying, plastic curing, and many similar processes. Treatment times hitherto reduced from hours to minutes by the use of radiant heat have now been further reduced to seconds. The secret of this high-speed treatment lies in the use of a special porous refractory brick. The element in simple form was developed some 30 years ago by Professor Bone, but since that time constant research and development have yielded an element capable of operating at a high radiant efficiency for the longest possible time with the minimum of maintenance. An overall efficiency of 90% with a radiant efficiency of 65%+ is obtained within two minutes of ignition. The elements are made in varying sizes from 1 in. diameter to 10 ft. by 6 in. In addition to many industrial applications the elements have been successfully incorporated in large scale cooking appliances, such as the well-known salamanders, grillers, and toasters. Radiant Heating, Ltd., have made quite a considerable contribution to the export drive and are selling successfully to the United States of America, Canada, South America, and other dollar-earning areas, as well as to Norway, Sweden, France, New Zealand, Australia, and South Africa. Mr. Therm, wherever he may be, need have no fears of his future while such firms as Radiant Heating, Ltd., are looking after his interests.

Grinding the basic material, prior to screening and weighing.

Temperature is important in preparing the bonding solution.



Moulding operation on a No 3 burner. Correct ramming skilful and essential.



Assembly of the base refractory block by W. Purvis, oldest member of the staff and part discoverer of the process.

Building up a No. 4 tunnel burner. The sugar boilers in the background are for sweet manufacture.

Arbitration Tribunal's First Case

AN application by Col. R. H. Studholme, on behalf of stockholders of the former Dudley, Brierley Hill and District Gas Company, Worcester, for the determination of values of certain classes of the company's securities, came before the Gas Arbitration Tribunal in London on May 10.

Mr. **R. C. Vaughan,** K.C., said the applicant claimed that the value of the 5% Consolidated Preference stock was £130 per £100, providing a yield of 3.85. The Minister of Fuel and Power contended that the proper value should be £115, with a yield of 4.35. For the 4% Perpetual debentures the applicant was asking £109 5s., yielding 3.66, against an offer by the Minister of £102 15s. with a yield of 3.89.

The applicant valued the 4½% Perpetual debentures at £121, yielding 3.72. The Minister's figure was £113 10s. with a yield of 3.96.

Maximum Dividends

Mr. Vaughan said the company had paid maximum permissible dividends on all its stocks for every year since the first available record in 1881.

Counsel said there were two issues of law which arose before the Tribunal could rightly say what were the relevant factors to which they were entitled to give consideration.

'First,' he said, 'at what date are you to assess the value of the securities? Secondly, is one of the relevant factors that you are entitled to consider the fact that from July, 1945, there was a threat of the nationalisation of the industry which, in fact, depressed its value?'

Referring to the fact that agreement had been reached between the Minister and the applicant on a price of £121, yielding 4.13 for the 5% Ordinary shares, Mr. Vaughan said: 'It may strike you at once as a little odd that the Preference stock should be valued at 6 points less than the Minister thought right and proper for the 5% Ordinary.'

The first witness, Sir **George Evetts,** O.B.E., a former director of the company, said in 1946 Ministerial consent was received for extensions to the works. The cost was two and a-half times greater than pre-war, but even with the increased capital expenditure there was no reason why the company should not have continued to pay a maximum dividend.

He agreed with Mr. **G. Upjohn,** K.C. (for the Ministry), that the plant put in in 1947-49 would soon have had to be supplemented with a much larger plant unless they were going to refuse further business.

Mr. **Francis Charles Briggs,** Divisional Manager, West Midlands Gas Board, said that the extensions to the works, which cost £300,000, had increased the output by 900 mill. cu.ft. a year to a total of 1,900 mill. cu.ft.

Mr. Vaughan submitted that there was nothing 'ultra plus' about the company because there were serious capital commitments in the future.

Snapped at the annual meeting of the North of England Gas Managers' Association in Newcastle (last week's Journal, *p. 391). Left to right: Front Row, Alderman C. B. Flynn,* O.B.E., J.P., *Member, Northern Gas Board; E. Crowther, Chairman, Northern Gas Board; C. H. Chester,* O.B.E., *President, Institution of Gas Engineers, Chairman, South Western Gas Board. Back Row, Left to right: J. W. Pallister, Middlesbrough; H. Forrest, President of the Association.*

Our photograph shows (left to right) Messrs. S. E. Whitehead, Deputy Chairman, Southern Gas Board, G .A. Matthews, Deputy Chairman, West Midlands Gas Board, and Alexander Tran, General Manager, Northern Division, Southern Gas Board. It was taken on the Oxford Works during the President's Day visit of the Midland Juniors (last week's Journal, *p. 383).*

Gas Engineers' National Guild

A meeting of members of the Gas Engineers' National Guild in the area of the Southern Gas Board, to form a Southern Branch of the Guild, will be held at 166, Above Bar, Southampton, on Saturday, May 20, at 3 p.m. An address will be given by the Executive Chairman, Mr. J. R. W. Alexander. All members of the Guild in that area and others eligible for membership (officers and senior or professionally qualified employees of the board) are invited to attend.

An East Midlands Branch of the Guild was formed at a meeting of members in the area of the East Midlands Gas Board, at Nottingham, on April 22, following an address by the Executive Chairman.

The Annual General Meeting of the Guild will be held at the Town Hall, Bournemouth, on June 6, at 5.15 p.m., following the adjournment of the business session of the Institution of Gas Engineers at the Winter Gardens nearby.

Parkinson and Cowan, Ltd.—The Directors of Parkinson and Cowan, Ltd., are recommending to their shareholders the payment of a dividend of 7%, less tax, on the Ordinary stock for the year ended December 31. Consolidated gross profit of the Group is £308,673, compared with £299,143 for the previous year, and net profit, after providing for depreciation, debenture interest, taxation, &c., amounts to £80,307, compared with £94,186 for the previous year.

British Industries Fair

The Birmingham Section of the B.I.F. contains the largest show of industrial gas equipment to be staged since the war. This year marks the return of the Gas Section, a review of which appears on this and subsequent pages, together with a brief description of exhibits by some of the many firms familiar to the gas industry.

DOMINATING the Gas Section at Castle Bromwich, the stand of the Gas Council is clean in design, well stocked with carefully chosen exhibits, and serves as an admirable representative of a progressive industry. An office structure spans the stand, from which six wall-like partitions each bearing on penants the name of two gas boards, divide the stand into four bays. Each partition carries panels describing in word and picture the use to which gas is put in various industries, together with examples of the articles so produced. The list is an interesting one and includes the manufacture of crystal glass, marine engines, broaches, vitreous enamelled baths, vacuum cleaners, cereal foods, vacuum flasks, textiles, sparking plugs, cutlery, scissors and surgical instruments, brake linings, toy motors, glass silk products, embossed velvet, toys, pottery, cables, bicycles, and plastics.

The stand is colourful, easily recognised, and a vast improvement on previous years. Moreover, it is not crowded, is pleasantly open and therefore inviting to the visitor, and encourages one to take a short cut across it—an extremely valuable point, since the visitor, once on the stand, is likely to be attracted by one of its features and pause to investigate. Another welcome change is the introduction of domestic equipment, of which a considerable selection is shown. Examples of home laundry equipment, water heaters, cookers, hot-plates, refrigerators, fires, radiators, portable heaters, boiling rings, and coke boilers, fires, stoves, and grates are all exhibited on the stand. A well-chosen commercial section includes the following appliances: A Benham two-unit solid top range, a Radiation 'Wardour' fish frying range No. 22, a Benham double deck pastry oven, a Main deep fat fryer GR. 91, a Main stock pot stove SP. 937, a Main boiling pan G.E.P. 25, a Radiant Heating radiant heat salamander, a Maxol café set with stand, a Sugg incinerator pedestal model No. 3706, and a Bratt Colbran incinerator.

Vertical Slot Furnace

As might be expected, however, the principal exhibits on the Gas Council stand are industrial in character. Of particular interest is a quarter scale working model of a vertical slot furnace manufactured by the Incandescent Heat Co., Ltd. Its purpose is the heat treatment (or re-heating) of ferrous or non-ferrous metals in the form of bars, strips, tubes, or sections. The original plant was designed for heating bars up to 15 ft. in length, for automatic delivery to a coiling machine for forming into helical springs, one hot bar being delivered to the coiling machine every thirty seconds.

The vertical type of furnace may be side or top-charged, and the small working clearances between the chamber wall and the tubes or bars, held horizontally and conveyed downwards, constitute the ideal form of heat exchanger, thereby promoting economy in fuel consumption. It dispenses with suspended crowns and other complications, and it may be of unlimited length without difficulty in construction, its capacity being determined by length and height, not by width. It is also particularly suitable for automatic feeding mechanisms, operating from the side, and will feed and discharge its load piece by piece. This furnace incorporates a multiple system of vetrical conveyor units on to which tubes, &c., may be charged, conveyed downwards at any required speed within the capacity of the furnace, and automatically discharged for further processing. The conveyor element combines a vertical or longitudinal reciprocatory motion with a rotative oscillatory motion. All the driving means are outside the furnace, and therefore not subject to heat, the working part of the element being in vertical suspension and consisting of the highest quality heat resisting metal. All the elements are mechanically interlocked from the point of charge to the point of discharge by a step continuous motion, discharging single pieces every few seconds or every few minutes according to the type of work. The mechanism can also be automatically interlocked with the machine which the furnace is feeding. The furnace operates at temperatures up to 1,000°C., and its rapid heating, completely automatic control, minimum use of floor space, and high capacity and efficiency are found to effect fuel saving of 25-50% depending on the type of work involved.

Town Gas Conversion Unit

Another important exhibit is a town gas conversion unit for horizontal steam boilers, designed by the South Eastern Gas Board. This equipment is capable of dealing with gas consumptions up to 5,000 cu.ft. per hour, and is suitable for the conversion to town gas firing of steam boilers such as the 'Economic' pattern, evaporating between 1,800 and 2,000 lb. water per hour from 212°F. The burner is a horizontal drilled pipe with a gas control cock at each end, fed from a constant pressure supply controlled by a relay valve of the complete closure type. To the centre of the burner is taken, from the inlet side of the relay valve, another small supply in which is included a combination damper cock, between which and the boiler flue damper is a cable connection, arranged to ensure that the damper is opened before the main burner is ignited. Included also in this small supply is a thermo-couple operated type flame failure device of which the thermo-couple is heated by the flame from a

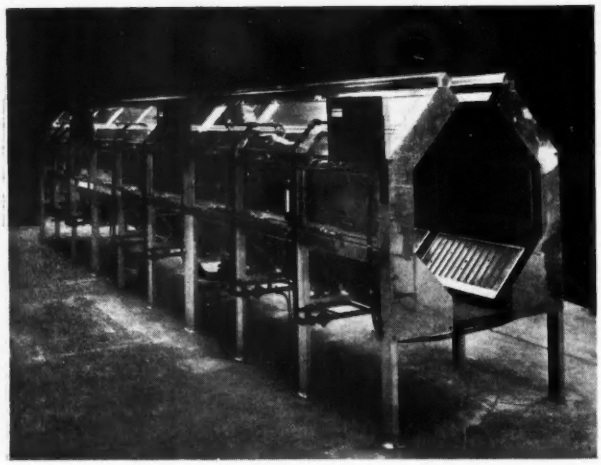
An excellent view of a corner of the Gas Council stand showing how the display panels are mounted.

small burner inserted through the main drilled pipe burner. The desired boiler steam pressure is controlled by means of a steam loaded pressure-stat connected in the 'weep' line of the relay valve. In effecting the conversion, the boiler firebars, supports, and front firing plate are removed leaving the combustion (flue) tube clear; the conversion frame, filled in with insulating refractory brickwork, is then fitted into the circular opening which is thus sealed except for the carefully proportioned rectangular flame port.

Tool Hardening Furnace

A tool hardening furnace, by Manchester Furnaces, Ltd., is also attracting considerable attention. This is a high speed steel hardening apparatus, with separate heating and pre-heating chambers; the operating temperatures are 800°C. in the pre-heating chamber, and 1.350°C. in the hardening chamber. A protective atmosphere is ensured by the introduction of a controlled supply of gas as a purging medium. Two air blast burners, firing through refractory orifices below the hardening chamber, are fitted, together with an air/gas ratio proportioning valve.

A number of burners, &c., are exhibited of which the following is a complete list: 'Hypact' burners, 'Aeromatic' injectors; and 'Aeromatic' industrial soldering and brazing iron (Aeromatic Co., Ltd.); laboratory and industrial bunsen burners and injectors (Amal, Ltd.); low pressure air-gas proportioning inspirator with governor and tunnel burner (British Furnaces, Ltd.); blowpipe (Fletcher Russell & Co., Ltd.); oxy-coal-gas hand cutter (Hancock & Co. (Engineers), Ltd.); high pressure gas soldering irons, automatic mixture control, high pressure gas strip burner, and high or low pressure gas cross-cut burner (Keith Blackman, Ltd.); low pressure gas injectors, tube firing burner, laboratory bunsen burners (Selas Gas & Engineering Co., Ltd.); concentrated combustion gas burner (Thermic Equipment & Engineering Co., Ltd.).



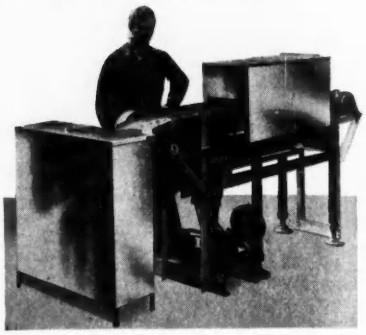
A paint drying plant by Neil & Spencer, Ltd., 24 ft. in length. This model, which contains 54 Bratt Colbran industrial units, has a maximum gas rate of 1,620 cu.ft. per hr.

The Gas Council stand is the focal point and co-ordinating feature of the Gas Section. The following exhibitors were also represented in this Section.

Aeromatic Co., Ltd., exhibit a pleasing range of industrial soldering and brazing tools, together with their well-known series of gas injectors. The latter are, of course, low pressure gas and air mixers, which have been designed and developed to improve the performance of atmospheric burners generally. Maximum aeration and minimum turn down are combined with the ability to withstand varying conditions of gas composition and supply, and (in the larger sizes) remote ignition are special features of the 'Aeromatic.' They can be used on furnaces, for process work, on central heating boilers, industrial installations, pasteurising plant, and on heavy duty catering equipment. The soldering and brazing tools include soldering irons of various types and the 'Aeromatic' No. 5 gas torch.

Bratt Colbran, Ltd., have an excellent stand which comprises three groups of exhibits. The first of these consists of the three types of overhead radiant heater, the luminous panel, the bowl, and the wedge. Models are shown 'live' with enlarged photographs of typical installations in factories, churches, schools, &c. The second group of exhibits contains industrial radiant units, which are flexible and self supporting, and may be built in oven form to the most suitable profile to fit the job. New applications for these units are being discovered in many industries, and amongst the installations completed during the past year have been ovens for washing machines, electrodes, pottery glazing, sewing machines and blacked foundry cores. A set of panels in a vertical mobile frame is shown. These can be brought up to process work which itself cannot be moved. The individual panels are adjustable from the vertical to 45° inclination, so that a variety of shapes can be successfully treated. The third group is devoted to sanitary incinerators, of a type exhibited for the first time this year. It has a rapid automatic action; the lever which opens the incinerator ignites the gas burner, and produces intense heat for a fixed period, reducing the contents to ash. If the incinerator is used again before combustion is complete, it continues to burn for a further period following the second insertion.

Geo. Bray & Co., Ltd., well-known manufacturers of flat flame and cylindrical jet burners for numerous purposes, exhibit a very wide range of products Flat flame cylindrical burners are designed for use on water heating appliances, canteen equipment, industrial purposes, cookers, wash boilers, fires, clothes drying cabinets, ovens, emergency lighting fittings, pilot lights, and other purposes. There are, moreover, a number of incandescent and petrol—air, gas burners, and atmospheric and non-atmospheric burners for acetylene. Not the least interesting development is the new spray jets, which have been adapted from the flat flame burners for use as a weedicide on crops.



A new high intensity radiant heat panel suitable for demonstration and testing purposes exhibited by Radiant Heating, Ltd.

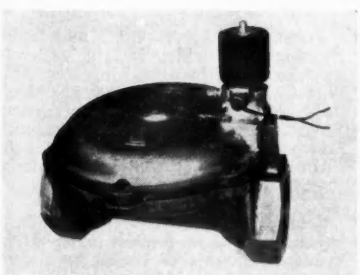
Chance Brothers, Ltd., can have every confidence that their stand will be readily recognised, for it carries a square beam airport location beacon, exhibited here for the first time. It is officially an electric beacon, and one such appears in the electrical section of the Fair. The reason it is included in this Gas Section is that the lamp used in the beacon is a special gas-filled one without which the beacon would not be the remarkable product it is. A range of 'Sumo' submersible electric pumping units is also shown. These compact portable units, from sizes to fit a 6-in. borehole upwards, are suitable for use in laundries, breweries, dairies, refineries, harbours and docks, and the smallest is capable of pumping a maximum of 3,000 gal. per hour. Advantages include portability, rapid installation, low-running costs, no shafts or bearings, no pumphouse, and no special maintenance. A demonstration of the 'Flamemaster' gas hand torch completes the exhibit. This is for use in light welding, and glass-working, weighs only 12 oz., and can be used with gas/air or gas/oxygen. Seven interchangeable flame units are available, and it has a built-in leak-proof economiser.

Cochran & Co. (Annan), Ltd., have, as the focal point of their exhibit, what is believed to be the largest boiler of its kind ever made. This is the Cochran gas-fired 'Sinuflo' boiler, which is 9 ft. in diameter and 9 ft. 3 in. in height. It is suitable for 120 p.s.i., but is arranged to work at 15 p.s.i.; it is fitted with 476 'Sinuflo' and 82 stay tubes, 2 in. o.d., and is complete with four quadrant burners carrying ¼-in. bore nipples, and mounted on 3-in. swivel cocks. Another interesting boiler shown is the Cochran multi-tubular vertical boiler which comprises a brick-lined combustion chamber plate, a smokebox, a chimney, and a set of Cochran mountings. Other pro-

ducts include pressure vessels, thermal storage accumulators, Cochran-Hopwood boilers for mobile plant.

A. E. Griffiths (Smethwick), Ltd., are, of course, noted for their work in designing and producing all types of ovens, both stationary and conveyor, for all enamelling, lacquering, cellulose finishing, and every drying operation by convection and infra-red process. On their stand a gas-fired, air-circulated convection oven is shown. It is intended for stove enamelling, low temperature heat treatment, &c. Also exhibited is a gas-fired radiant heat drying oven with hand control and temperature indication. On the same stand Modern Furnaces and Stoves, Ltd., show a 'Newstad' patent gas-fired skin-drying plant for factory moulds, a gas-fired 'Traykor' core-drying oven, operating on the 'Newstad' recirculation system, and 'Newstad' vortex gas burners.

Heat & Air Systems, Ltd., are exhibiting their heaters for the first time at the B.I.F. There are two major exhibits on their attractive stand—the H.A.S. indirect gas-fired space heater, and a gas-fired heat exchanger battery. The former, size 20, has a capacity of 100,000 B.Th.U. per hr., and is a completely self-contained unit, available in several sizes for heating factories, stores, offices, halls, &c. It can also be arranged with ducting to form a central heating and ventilating system. The heat exchanger battery can be built into central ventilating systems or adapted for process air heating requirements up to 500°F. Batteries can be built according to the capacities required, and special designs are available. It is of substantial welded construction and can be used to heat air through the normal range for space heating, or up to 700°F. for process purposes. It is provided with an air-cooled outer casing with angle flanges for connecting into a system of ducts, and the burner equipment has neat flame tips for the lower temperatures, and bunsen type for the higher range. Both are provided with the necessary gas controls including pilot and flame-failure devices.



A newly patented design of magnetic gas valve exhibited by Perl Controls, Ltd.

Maxol Heaters, Ltd., exhibit their full range of heaters and equipment, of which the following are good examples. The Maxol café sets incorporate the well-known B.D. boiler, and the coffee and milk urns are independently heated by patented gas burners, each urn being thermostatically controlled. The temperatures for milk and coffee are set at 150°F. and 180°F. respectively, but can be set to any degree to suit individual requirements. This independent heating of the side urns, in addition to ensuring and maintaining positive temperatures, makes the café set well suited for use in hard water districts. In the Maxol hot cupboard with bain marie, the hot cupboard temperature is thermostatically controlled, and on the bain marie top, the food containers are immersed in a heated water well, the level of the water being automatically maintained by ball valve cistern feed. The multi-point heater is specially designed to supply hot water at several points for cafés, canteens, factories, hairdressers, &c. Thermostatically controlled, it is soundly constructed of heavy gauge copper, and is available in polished copper or chrome plated finish. The Maxol S.1 sink heater is specially designed to suit all water pressures, and gives boiling water or hot water at any temperature required; the flow is not affected by low water pressure. Gas and water are controlled by a single action valve. The S.2 quick recovery storage heater is an attractive modern appliance, a feature of which is the exceptionally quick recovery rate. The contents of the heater are raised from cold to 160°F. in seven minutes. It is thermostatically controlled.

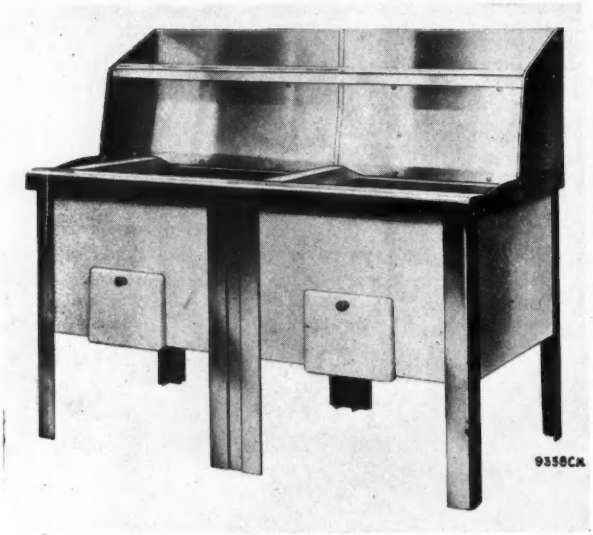
Neil & Spencer, Ltd., offer an interesting exhibit showing their gas-fired infra-red drying plant. The principal example shown is a Teleflex conveyor, 3 ft. in diameter, going through a vertical bank of Bratt Colbran radiant panels. Neil & Spencer, Ltd., specialise in designing and building up drying ovens for a wide variety of purposes. Also shown on the stand are pre-heating ovens, and degreasing and washing-off tanks.

Perl Controls, Ltd., exhibit a range of 'Perl' automatic temperature and safety controls, of which the most interesting features are the new sizes of 'Thermoperl' electro-magnetic pilot safety valves, the larger one being suitable for 1½ in. gas supply, rating 900 cu.ft. per hour, and the newly- patented design of 'Perl' magnetic gas valves, sizes 1¼ in. to 6 in. B.S.P. The latter valves are of relay type, with a built-in, two-way pilot magnetic valve, consisting of solenoid, armature and metal seated valves. Rapid shut down (4 to 10 seconds) is assured with only momentary weep gas flow. Opening is adjustable to give smooth ignition of the appliance, and they will not set up shock pressure waves in the gas supply. They are suitable for almost all industrial applications where gas-fired equipment is used in conjunction with electrically-operated controls, closing automatically in the event of failure of the electric supply. Thermostats of the industrial type are exhibited, and boiler-stats, covering temperature ranges from 0 to 800°C., with stem lengths from 4 in. to 48 in. Also shown is the direct operating type for ¼-in. B.S.P. supply.

A general view of the stand of Perl Controls, Ltd.

Radiant Heating, Ltd., have, as the main feature of their stand, a high intensity radiant heat tunnel which is a working unit suitable for demonstration and testing purposes. It is fitted with a variable speed conveyor, giving speeds from 5-20 ft. per minute. Two No. 1 type surface combustion units are fitted in the roof of the tunnel to give 24 in. of direct radiation on the conveyor when the latter is at 5⅜ in. from the radiant heat source. The tunnel is 3 ft. 3⅜ in. long, a short air sprayed flashing chamber preceding the radiant heat zone. Fan air is used to inspire the necessary gas through special gas-air mixers, the total gas consumption being 0.6 therm per hour. Among other exhibits a sugar boiler, capacity 30 lb. with a boiling speed of 15 min., a radiant heat salamander, and an automatic toaster capable of producing 540 slices per hour, should be of special interest to the confectionery and catering industries. Also shown is the well-known range of space-heating appliances, and special displays are given of the 'Duoflam' burner units.

Radiation Ltd., have departed from the precedent of the last three years by showing a wide range of cooking apparatus suitable for both town and natural gas. Typical appliances adapted for both fuels are available for demonstration. One of the most interesting exhibits is the new 'Kingfisher' unit fryer, which permits suites to be built up to meet requirements. The steel chassis structure ensures maximum rigidity and supports the pan and cornice, which are one-piece mild steel fabrications. The burner unit is fitted with a pilot, is thermostatically controlled, and can readily be removed for cleaning and maintenance. Maximum insulation is provided, which together with screening of the cornice, ensures both minimum gas consumption and comfortable conditions for the operator. It is fitted with aluminium back and side screens and aluminium alloy rack housing draining trays. Another interesting appliance is the new pressure steaming oven which was shown for the first time at the Hotel, Restaurant, and Catering Exhibition. This oven is operated by live steam at 5 lb. pressure and is available in three sizes; it can be built up in the form of batteries to suit requirements.



The newly-designed 'Kingfisher' deep fat fryer, by Radiation Ltd. Constructed on the unit principle, these appliances can be built up in suites to meet individual requirements.

Selas Gas and Engineering Co., Ltd., have a pleasant stand which exhibits examples of their wide range of combustion engineering equipment, including air-gas controlling, proportioning apparatus, compressors, heat treatment and metal melting, furnaces, burners, and accessories. Particular mention might be made of the new ladle-drying gas burner units for heating and drying steelworks and foundry ladles of moderate and large capacities in the normal, upright position. The burner unit comprises two heat resisting iron castings of different sizes but of corresponding hemispherical shape. The bowl of the smaller casting is the gas chamber having a flat circular top plate cast integral. Nine burners are provided in the lower part of the outer casting, eight being arranged for a declined angle of firing, the remaining burner being centrally situated underneath for firing directly downwards. Gas from the inner chamber is fed through jets running across the air space and then concentrically into outer tubes or nozzles connected to the air chamber. In this manner burners of the nozzle mixing type are formed, with the air-gas mixing position at the root of the flame, offering a maximum degree of regulation for flame size and intensity, a wide and flexible turn-down range, and eliminating the risk of backfires. A continuous ring of secondary air ports in the upper part of the outer casting ensures the combustion of any unburnt gas from the flame zone, and assists in directing the rising hot gases against the inner surfaces of the ladle. When required for use with town gas, coke oven gas and similar gases, the burners are arranged for operation on a gas pressure of approximately 3 in. W.G., in combination with a separate air supply at a pressure of from 16-20 in. W.G. at the burner inlets.

Sperryn & Company exhibit their full range of spring loading and self-lubricating main cocks on an attractive stand. Working models demonstrate the working principles of thermostats and relay valves, and there is a wide range of 'Spersom' thermostats, both domestic and industrial, and the latest designs in aluminium relay valves. Another working model displays the latest patented development of the 'Spersom' safe control pilot. This development enables the thermo-magnetic device to be used to give full protection to multi-burner gas appliances. It can accommodate an unlimited number of burners, and ensures protection to each individually at a very moderate cost. The exhibit also includes Sperryn electrical accessories of various types.

Wm. Whitehouse & Co., Ltd., on an attractive corner stand, exhibit an impressive range of small gas fittings of every description. Of particular interest is a new safety head locking tap which is extremely neat and effective, and which replaces the former drop-head tap. Other exhibits include gas main cocks, union cocks and joints, floor cocks, plug-in cocks, stove cocks to makers' own patterns, &c.

Other Exhibits of Interest

A.C.E. Machinery, Ltd., have two stands at Castle Bromwich this year, one indoor and one out. Both effectively demonstrate the company's specialised interest in machinery for elevating and hoisting plant. Tower mast platform hoists are available from 5 to 50 cwt., concrete elevating plants from 5 cu.ft. to ¾ cu.yd.; both are easily erected and suitable for heights up to 400 ft. A number of winches are also manufactured, ranging from 4 to 40 cwt., which are suitable for building use, steel erecting, &c.; portable winches range from 5 to 10 cwt. Of principal interest to the gas industry, however, are the coke debreezing screens. It is claimed that nine out of ten London and Home Counties gas-works use the A.C.E. 2 ft. screening unit which has an output of 20-25 tons per hour.

Acme Wringers, Ltd., exhibit something new at this year's Fair—the inclusion of 'pressure indication,' a development which by assuring the correct pressure for every kind of fabric, 'takes the guesswork out of wringing.' It is claimed that more than four million Acme wringers are in use throughout the world. The stand is of unusually attractive appearance.

The Aerograph Co., Ltd., exhibit their well-known range of Aerograph-Devilbiss spray guns for all painting purposes, ranging from motor car and furniture manufacture to stencilling and art work. Exhibits include pressure feed tanks, paint circulating systems, air transformers, air compressors, spray booths and exhaust fans, portable air compressing plants, and artists' air brush equipment.

William Allday & Co., Ltd., have a pleasing stand which is largely devoted to a display of industrial furnaces for all duties, various types of tinsmiths' equipment, high, medium, and low pressure fans; portable forges, blacksmiths' hearths, tools, and equipment; and a considerable range of tools for soldering, brazing, and model making.

John Allen & Sons (Oxford), Ltd., on an outdoor stand, display trench cutting machines capable of cutting to a depth of 14 ft. and to widths up to 5 ft. Also shown is a super-duty mobile shovel crane which can travel from site to site under its own power and can carry out many small jobs which, it is claimed, normal crawler-mounted machines could not do economically.

Aveling-Barford, Ltd., exhibit an interesting range of trench cutting machines, and a number of machines largely associated with building or road maintenance, such as a vibratory concrete finisher, Diesel shuttle dumpers and rollers. Of particular interest to readers is the versatile calfdozer which is admirably suited for shifting coal or coke with

- ● ABERDEEN
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- ★ BOW COMMON, LONDON
- ● BRADFORD
- ★ BRIDGWATER
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- ★ BRISTOL
- ● BURTON-ON-TRENT
- ★ CAMBRIDGE
- ● CHELMSFORD
- ★ CHELTENHAM
- ★ CHESTER
- ★ CLECKHEATON
- ● COLCHESTER
- ▲ COLVILLES (GLASGOW)
- ★ CROYDON
- ★ DAWSHOLM, GLASGOW
- ★ DONCASTER
- ● DUDLEY
- ★ DUNSTABLE
- ▲ EBBW VALE
- ★ EDINBURGH
- ● EPPING
- ★ EXMOUTH
- ★ FULHAM
- ★ GAINSBOROUGH
- ● GLOUCESTER
- ★ GREENOCK
- ★ HAMILTON
- ★ HARROGATE
- ★ HILSEA
- ★ HYDE
- ★ IPSWICH
- ● KENSAL GREEN, LONDON
- ★ LOUGHBOROUGH
- ★ LUTON
- ▲ LYSAGHT (SCUNTHORPE)
- ★ MANCHESTER, BRADFORD RD.
- ● MANCHESTER, PARTINGTON
- ★ MONMOUTH
- ★ NEWCASTLE-UNDER-LYME
- ★ NEWTON-LE-WILLOWS
- ★ NEWTON-ON-AYR
- ★ NOTTINGHAM
- ★ ODENSE, DENMARK
- ● OLDHAM
- ▲ ORGREAVE (ROTHERHAM)
- ● PAISLEY
- ★ PETERBOROUGH
- ● POOLE
- ★ PRESTATYN
- ▲ PRETORIA, SOUTH AFRICA
- ★ PROVAN, GLASGOW
- ● READING
- ● REDDITCH
- ★ ROCHDALE
- ★ SALTLEY, BIRMINGHAM
- ★ SHEFFIELD
- ★ SHREWSBURY
- ★ SMETHWICK
- ★ STAMFORD
- ★ STOCKPORT
- ★ STOURBRIDGE
- ● SUDBURY
- ★ SWAN VILLAGE, BIRMINGHAM
- ● TINGLEY
- ● TIPTON
- ★ TOTTENHAM, LONDON
- ▲ VANDERBIJL PARK, SOUTH AFRICA
- ★ WALLASEY
- ★ WALSALL
- ● WANDSWORTH, LONDON
- ★ WARRINGTON
- ★ WELLINGTON
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a minimum of time and trouble; it is claimed that its work equals that of ten men using shovels and barrows. The 4 ft. 6 in. blade can be swung from right or left for angle-dozing.

C. R. Averill, Ltd., on a colourful stand, exhibit their silica-graphite paints for iron and steelwork protection, 'Avarc' synthetic finishes for industrial and decorative uses, and 'Avarc' lubricating graphite specialities, greases, jointing compounds, &c. An interesting and attractive feature of the stand is a display of process panels showing the use of 'Avarc' paints where resistance to heat and chemicals is essential.

Babcock & Wilcox, Ltd., have as their centre-piece various exhibits illustrating the new Babcock 'Cyclone' boiler. An excellent model of the boiler to half scale (13 ft. wide, 6 ft. deep, and 14 ft. high) is accompanied by a model of the Babcock 'Radiant' boiler equipped with 'Cyclone' furnaces, and a daylight cinema projecting cabinet. A full-size installation in a sectionalised Lancashire boiler flue of the 'Oldbury' patent chain grate stoker with ash extractor is also shown.

Birlec, Ltd., have five working exhibits on their stand. This is truly 'a stand in production,' for two continuous furnaces are handling work for prominent Midland manufacturers, and a gas plant is producing the atmosphere ancillary to their operation; a high frequency induction heating unit is hardening automobile gear box sleeves, and a high frequency spark gap set is melting small charges of cast iron. A laboratory size Birlec-Detroit arc-melting furnace is also on show. Equipment on view includes the Birlec shaker hearth furnace and the 'Endothermic' gas plant.

The Birtley Co., Ltd., specialists in earth-moving equipment, exhibit their impressive 18-cu.yd. scrapers, and three sizes of hydraulic angling bulldozers to the specification of the Caterpillar Tractor Company, Peoria, U.S.A.

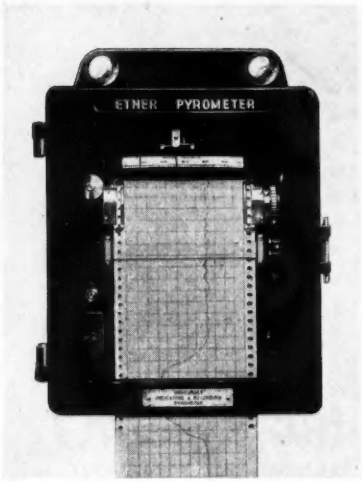
Bitulac, Ltd., have a particularly attractive stand on which an infra-red dipping and stoving machine is in operation, demonstrating the firm's well-known range of stoving enamels. The latter are available in all colours, for infra-red or convection stoving. Also shown are 'Polo' brand high gloss enamel paint, 'Puma' hard gloss paint, and genuine bitumen paints in selected colours.

E. Boydell & Co., Ltd., exhibit, in their Muir-Hill range of equipment a more robust model 14B dumper and a loader of greatly increased versatility, due to additional ancillary equipment, together with the models 10B diesel and 10B petrol dumpers of 3 cu. yd. capacity, and the 20B dumper of 6½ cu. yd. capacity. It is of interest to note that the loader can now be supplied with any of the following attachments: A ¾-cu.yd. bucket as standard; a 1-cu.yd. bucket of similar design; a special full width 1 yd. bucket; a dozer blade and two types of crane attachments, which enable it to be used as a 1-ton mobile crane.

British Ermeto Corporation, Ltd., exhibit self-seal couplings which are capable of withstanding extremely high pressures and vibration. Straight couplings, male and female stud couplings, elbows and tees and available in steel and brass in all common pipe sizes. Also shown were shut-off and flow control valves for oil-hydraulic pressures which are machined from steel bar stock and are designed for hydraulic pressures up to 5,000 p.s.i.

British Fittings Co. (Hendon), Ltd., are represented at the Fair and exhibit malleable iron tube fittings for steel tubes for use with gas, water, air, steam, and oil. Worthy of particular mention are the triple-seal adapter unions which will join two plain end tubes together without screwing, or any malleable or wrought fitting to a plain end tube.

British, Foreign & Colonial Automatic Light Controlling Co., Ltd., have an attractive stand which displays to advantage the firm's range of clockwork control mechanisms for electric switching and recording apparatus. Also shown are process timers, time lags, &c.



One of the exhibits on the stand of Ether Ltd.—an 'Indicorder' controlling and recording pyrometer, type C.R.M.S.

British Jeffrey-Diamond, Ltd., exhibit an impressive range of equipment which includes the 24-in. and 36-in. Mark II single roll breaker, the Mark I flextooth crusher, a swing hammer pulveriser, and 'Atomill' high speed fine grinders. It is emphasised that these machines can produce the required product in one passage through the machine.

The British Thomson-Houston Co., Ltd., on an excellent stand, display equipment of wide variety. Included are some of the following items: Switchgear, mining equipment, a flameproof contactor unit, electric traction equipment, a number of industrial and small power motors, electro-hydraulic thrustors, electric control gear, industrial heating equipment, &c.

British Tyre and Rubber Co., Ltd., describe themselves as engineers in rubber—'artists' might be a better term. The interesting exhibits shown here include B.T.R. conveyor and transmission belting, 'V' belts, hose, tubings, flexible pipes, anti-vibration mountings, rubber mouldings, linings, coverings, rubber-lined bearings, anti-corrosive rubbers, extruded rubber products, rubbered rolls, and rubber-to-metal components, &c.

British Vacuum Cleaner & Engineering Co., Ltd., are, of course, specialists in industrial vacuum cleaning and the firm exhibits a number of interesting types of equipment. One example is the B.V.C. model T87, for the removal of flue dust from steam boilers. Other exhibits include pneumatic and mechanical conveying plant, and ash sluicing plant.

Brockhouse Heater Co., Ltd., exhibits their well-known gas-fired steam boiler units which feature a special air induction tube, which regulates the amount of air admitted to firing tubes. The boilers are available in a range of sizes from 30-400 lb. of steam per hr. The Brockhouse automatic condensate is supplied complete with drawing, wiring diagram and fixing instructions ready for connection to steam condensate mains to give automatic control.

Broom & Wade, Ltd., have an outdoor exhibit showing air compressors and pneumatic tools. The Type D.23, single-acting, single-stage, water-cooled compressors deliver 200 cu.ft. of free air per min. at 100 lb. per sq. in. working pressure at 300 r.p.m. There is a wide range of pneumatic tools, from which might be selected for comment the Type NV.25 rotary immersion concrete vibrator. Other exhibits include rock drills, sump pumps, &c.

Cambridge Instrument Co., Ltd., display, on an effective stand, a wide range of measuring instruments of mercury-in-steel and vapour-pressure types, for all processes. Indicating dials from 4 in. to 8 in. diameter are shown, and a selection of draught and pressure gauges and recorders.

Tom Carrington & Co., Ltd., have, as a major attraction on their stand a portable power screwing machine at work. Other exhibits include taps, dies, die-stocks, tap wrenches, ground thread taps, chaser die stocks, pipe cutters, tools for plumbers, pipe fitters, electricians, and screwing tools of every description.

Cellactite & British Uralite, Ltd., exhibit a large variety of covering materials, ranging from asbestos protected steel-cord roofing to vertical covering and ventilators. Of particular interest are 'Kimolo' insulating bricks and slabs for the insulating of industrial furnaces and ovens, and light-weight hollow partition blocks.

Chaseside Engineering Co., Ltd., exhibit a number of new additions to their range of machines. These include an interesting 1-cu.yd. loading shovel for coal and coke handling, which is available in four distinct types, a Chaseside brickstaker attachment, a Chaseside angle-dozer, and a Perkins P.6 diesel engine.

Clifford Products, Ltd., exhibit the 'Hotsprings' shower and airing cabinet which created so much comment at the Ideal Home Exhibition. The cabinet is constructed of heavy gauge aluminium and finished in cream stoved enamel. The stand also includes the range of Clifford range of domestic gas cookers for town gas and butane.

George Cohen, Sons & Co., Ltd., have an outdoor exhibit which comprises a wide range of power presses, sheet metal and plate working machinery, hydraulic

presses, &c. Special mention should be made of the Jones K.L. mobile cranes, of which the K.L.100 shunting crane is the most interesting, having a maximum lifting capacity of 5 tons, and an electro-magnet, energised from a 2½ kW generator driven by the crane's own diesel engine.

The Consolidated Pneumatic Tool Co., Ltd., also have an outdoor stand which exhibits all six sizes of air compressors, ranging from the two-wheeled 63-cu.ft. capacity machine to the 500-cu.ft. model; the latter is a new design. The Class 2B stationary, horizontal air compressor is also new, and is used for sub-aqueous tunnelling and similar work. The Class T.B. compressor has a type of unloader on the pressure regulator which will govern pressure variations to a limit of 2 oz.

The Copper Development Association has a magnificent stand which takes full advantage of the visual appeal of the product concerned. The stand itself is used largely as an information bureau on the suitability of copper for various types of work.

Cuxson, Gerrard & Co., Ltd., exhibit metal valves, of both globe and gate patterns, suitable for working pressures and temperatures, and made with either screwed or flanged connections. Certain globe valves are suitable for steam working pressures up to 250 lb. per sq. in. and a total temperature of 500° F. Various malleable pipe fittings, &c., are also shown.

Cuxon, Gerrard & Co., Ltd., exhibit their well-known range of medical and first aid equipment, which includes everything for the industrial first aid room, such as first aid cases, stretchers, surgical dressings, &c.

Eagle Range & Grate Co., Ltd., exhibit models of cookers, fires, controlled combustion stoves, combination grates, flue sets and coke heaters. Some of these are entirely new in design and others incorporate improved features. Visitors to the stand can see a cooker, a fire, a combination grate, and a convector grate in operation, as a few of the models, including the new No. 11 'Yeoman' side-oven combination grate, are alight and under working conditions.

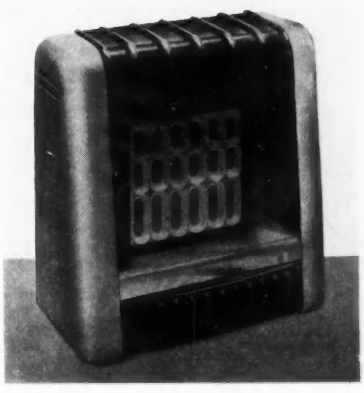
The Electric Construction Co., Ltd., exhibit their wide range of electrical machinery for industrial purposes. Among the varied types of equipment shown are a rectifier with transformer, a direct current motor, three-phase motor starting gear, automatic control gear, and ammeter, voltmeter and electronic devices.

Elliott Bros. (London), Ltd., have an excellent stand containing an extraordinary range of scientific and industrial instruments. Outstanding features include the 'Elliottronic' potentiometer recorder, the 'Elliottrol' system of automatic process control, various electrical measuring instruments, the Elliott-Shotter system of remote indication and control, magnetic amplifiers and their application to automatic control of furnaces, &c.

Ether, Ltd., feature a number of recent developments in connection with automatic control of temperature. The Ether-Wheelco range of electronically-operated temperature controllers is shown, together with an Ether-Gordon 'Xactline' anticipatory control device which will provide straight-line temperature from the most refractory furnace. The 'Flame-otrol' combustion safeguard is exhibited with electrodes for use in conjunction with gas-fired apparatus.

Evered & Co., Ltd., have an attractive stand which embraces this firm's widely varied products. These range from metal and plastic builders' hardware to non-ferrous metal, tubes, &c. Familiar to the gas industry, however, is the series of compression joints and various gas fittings, and light engineering equipment.

Ewart Chainbelt Co., Ltd., exhibits working models of mechanical handling plant for bulk material and packages, chains of many types in malleable iron and steel for such purposes as conveying, elevating, and transmission. The stand also includes sprocket wheels, elevator buckets, &c.



Shown for the first time at the B.I.F. is this new portable gas fire by John Harper & Co., Ltd.

Fibreglass, Ltd., have a novel stand, the centrepiece of which is a boiler, with a district heating scheme on one side and an overhead steam system on the other, the latter feeding a turbine and then passing out to process work and factory heating. 'Superfine fibres,' which are 500 times finer than human hair, are displayed on a side panel.

Foster Instrument Co., Ltd. A wide variety of recording instruments make this an interesting exhibit. Among the instruments shown are various types of pyrometer, electrically-operated control valves, electric resistance thermometers, and introscopes for internal inspection and industrial microscopes.

Gittings & Hills, Ltd., exhibit articles coated with their industrial finishes demonstrating 'Rockhard' synthetic stoving enamels, 'Lustreloid' cellulose lacquers, 'Githilac' oil-resisting machinery enamels, synthetic and oil air drying and enamels, and high temperature blacks.

Goodyear Tyre & Rubber Co. (G.B.), Ltd., have an excellent display of various industrial rubber products. Of particular note is the rubber-impregnated conveyor and transmission belting. Also shown are Vee-belts, endless cord belts, industrial hose, and the conveyor belt splicing service is also stressed.

John Harper & Co., Ltd., show for the first time the Harper 4015 portable gas fire, which is lightweight, finished in heat-resisting cream enamel with chromium-plated reflector, portable, and merely needs to be coupled to a convenient gas point. Pressed steel gives lightness and strength and the gas consumption of 8.5 cu.ft. per hr. provides comfortable heat from the attractive one-piece radiant. The height is 10⅞ in., the width 9¼ in., and the depth from back to front 8½ in.

Harris Engineering Company have a neat stand which effectively shows the firm's range of gas unit heaters and safety devices, ventilating equipment, and powder mixers.

G. A. Harvey & Co. (London), Ltd., exhibit their customary wide range of perforated metals, woven wire gauze, and gilled tubes. A prominent exhibit on this stand is the new 'Harco' glazed office partitioning. Hygienic in design to eliminate all dust crevices, this partitioning is also designed on the unit principle, thereby giving the greatest elasticity in arrangement and allowing alterations and additions to be made with the utmost facility.

Hills (West Bromwich), Ltd., exhibit, on an impressive stand, permanent steel framed school construction, structural steel, lead and aluminium roof glazing, metal windows and doors, reinforced concrete products, ventilating shutters, 'Accordo' sun blinds, pressed steel trim, and copperlight and leadlight glazing.

Holman Bros., Ltd., are specialists in compressed air plant, and their stand gives an excellent impression of the wide scope of their products. Shown is compressed air plant for mining, quarrying, public works, general engineering and industrial purposes, including air compressors, rock drills, air motors, winches, pumps, concrete compactors, and many types of pneumatic tools.

Imperial Chemical Industries have two stands at Castle Bromwich, publicising the Metals Division and the Plastics Division. On the former is staged a working laboratory showing how spectographic methods are employed for the analytical control of its products. Sheet, strip, tubes, rods, wire, and similar products are attractively displayed.

The Incandescent Heat Co., Ltd., have an excellent stand on which models mounted on moving conveyors and photographs show furnace and foundry equipment from the firm's range of products. Metallurgical furnaces and ancillary equipment are shown, and also vitreous enamelling plants, continuous pottery and ceramic kilns, galvanising plant, and furnaces for hardening, gas carburising, annealing, &c.

International Combustion, Ltd., exhibit some of the latest developments in steam generation and milling on an effective stand which includes model water-tube boilers, pulverised fuel or stoker fired, travelling grate and spreader stokers, material handling equipment, and various types of milling equipment.

Jenolite, Ltd., have as the centre of their stand a perfectly scaled small model of a modern metal pre-treatment plant. This consists of four tanks in a row, a de-

greaser, two Jenolizing (rust preventative) tanks and a hot rinse tank. New products include the paint stripper (P.S.5) and the new A.K.S. (aluminium keying solution), which provides a perfect keying surface for aluminium panels. Formerly the only way to prepare these for paint application had been harsh abrasives, but now a single cold brushing on of the chemical will provide a keying surface for any varnish or paint.

C. H. Johnson (Machinery), Ltd., the well-known public works and contractors plant manufacturers, exhibit a wide range of screening, conveying, and elevating plant, concrete vibrating and mixing machines, centrifugal and diaphragm pumping equipment, pile drivers, runabout electric cranes, &c.

Kleen-e-ze Brush Co., Ltd., have an interesting exhibit which reveals a multitude of products for individual industrial purposes. Compression guns and bullets for condensers, 'Kezcoil' flow-breakers for heat exchangers, brush-welt draught excluder, 'Keza' tube burnishers, and other types of mechanical brushware are exhibited. Of interest also is 'Florigene' dust-allaying fluid.

James H. Lamont & Co., Ltd., exhibit 'Securex' patent improved fittings for light and heavy gauge copper tubes for cold and hot water supply and steam heating. The three parts can be assembled in two minutes with only a small expanding tool and a spanner. The joint is rustproof, will not fur, and remains tight despite side pressure or variations in temperature.

The Lead Wool Co., Ltd., have a neat stand which shows to advantage the company's many grades of steel wool, air conditioning filter pads in steel, brass, copper, aluminium and other metal wools, and engine air intake filter elements.

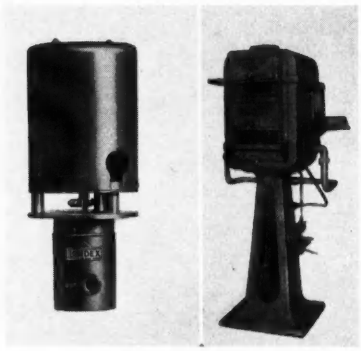
Londex, Ltd., exhibit electro-magnetic relays and contactors, process timers, photo-electric equipment, liquid level control equipment, and electro-magnetic counters. In addition, Londex flow indicators are demonstrated. This patented equipment safeguards plant by checking the flow of liquids, such as cooling water and lubricating oil. It can be arranged to maintain a lamp flickering during flow, or to give a warning, shut down a machine, start a motor, or start standby equipment should the flow cease.

Donald MacPherson & Co., Ltd. Of particular interest to gas engineers are improved gasholder and steelwork protective paints. Special quick drying enamels, giving highly glossy finish with low dirt retention, and capable of being repeatedly washed and cleaned without detriment to the surface, are exhibited under testing conditions, for the interiors of engine and compressor houses, &c. Durable finishes for meters and other appliances are available, and a special feature this year is the firm's exhibit of their motor body finishing products. In addition, a special exhibit of a model engine shows the Foo-3-4 engine enamels.

The Morgan Crucible Co., Ltd., exhibit crucibles, furnaces and foundry equipment, 'Morganite' carbon brushes for electrical machines, 'Morganite' carbon engineering parts, sintered metals, 'Carbinert' impervious graphite, engineering components, 'Triangle' refractories, including pure oxide ware, and refractory concrete.

R. H. Neal & Co., Ltd., have an outdoor stand which contains the latest models of Neal's mobile cranes, including a new 10 tons capacity pneumatic-tyred, diesel-driven crane which incorporates a number of new features.

Oldham & Son, Ltd., have a stand which includes a full range of batteries for the lighting and starting of every type of motor car and commercial vehicle, traction batteries for electrically-operated vehicles and fork-lift trucks, as well as marine batteries. Lamps for industrial purposes are also shown, notably the 'Tanka' safety hand lamp, for use in explosive atmospheres.



At the left is an electro-magnetically operated gas valve by Londex Ltd. On the right is a tool hardening furnace manufactured by Manchester Furnaces, Ltd., which is shown on the Gas Council stand.

An interesting highlight is an illuminated model of a self-service lamproom, which has been specially made by Oldham & Son for the Science Museum. Measuring 9 ft. 6 in. by 4 ft. the model is complete in every detail.

The Park Foundry (Belper), Ltd., feature a cooker, a fire, a combination grate, and a convector grate in operation, as certain of the models, including the new No. 11 'Yeoman' side oven combination grate, is alight under working conditions. The well-known 'Siesta' openable stoves are on view, as are the 'Chevin' smokeless fuel grates and convector fires. Several of these models are entirely new, while others embrace certain new features.

Pegson, Ltd., have an outdoor stand which shows a large range of heavy equipment including stone crushers (gyratory and jaw types), vibrating screens, counter current concrete mixers, concrete tile machines, centrifugal pumps, petrol-operated road breakers.

Range Boilers, Ltd., exhibit the following products on their attractive stand: Copper cylinders, calorifiers, combination tanks, copper and steel boilers; all types of domestic institutional industrial water heating and storage apparatus, solid fuel, gas, electricity and steam; general copperwork, brasswork and various special products, &c.

The Rawlplug Co., Ltd., exhibit their well-known range of fixing devices, soldering equipment, and sealing compounds. A new item, however, is a squeakproof nut which enables an unskilled person to make a rigid fixing which will not loosen through vibration or stress within wide limits. It is claimed that thousands of fixing jobs in building, ship building, aircraft, automobile, electrical and radio industries can be tackled by this new product. The action of turning screw in nut causes a tough rubber bush to be drawn tight to form a strong 'rivet head.'

The Rheostatic Co., Ltd., specialise in temperature control devices. Their stand includes the following exhibits: Automatic temperature controls, including modulating valves, mixing valves, motorised valves for water and steam, gas valves and safety controls, electric water heater and cooker thermostats, and oil burner and stoker controls.

J. Rowell & Son, Ltd., have a stand which is divided into two main types of exhibits. Of major interest to the gas industry are the 'Thermecon' gas boilers and burner products, but attention should also be given to the 'Ace' electrically-operated washing machines, which have an entirely new agitation principle. Also shown are 'Ace' hand-operated models —cabinet, standard, de luxe, and junior.

R. Russell & Sons, Ltd., show the 'Dainty' gas cooker which is specially constructed of cast iron to give strength and durability, in vitreous enamelled finish, with a heat-controlled oven, griller and three boiling burners.

Saunders Valve Co., Ltd., have a central feature consisting of a combined valve and pump display, demonstrating the easy flow and sure closure of Saunders diaphragm valves and the good delivery of 'Safran' pumps. Sectioned models of small and large valves show the advantages of isolating the operating mechanism. For diaphragm valves for use with widely varied industrial liquids, a range of diaphragms and of bodies in cast iron, stainless steel, bronze, aluminium, &c., is shown.

Siebe Gorman & Co., Ltd., exhibit their well-known range diving, breathing, and resuscitation apparatus. Included on the stand are gas and dust masks, medical equipment, reducing valves, goggles, and other protective devices for industrial workers. The 'P.S.' carbon monoxide detector, which comprises a tube containing silica gel impregnated with a complex palladium salt which changes colour upon contact with carbon monoxide, is a particularly interesting item.

Sigma Instrument Co., Ltd., contribute an interesting stand which shows multi-dimension inspection machines in operation, which are designed for rapid inspection of mass production; they are hand-operated, semi-automatic, or fully automatic, according to individual requirements.

Jas. Southerton, Martineau & Smith, Ltd., have a pleasant stand which displays their considerable range of products. These include stove fittings, gas fittings, water fittings, steam fittings, and spraying machines and lubricators.

Stamford Engineering Co., Ltd., display, on an effective stand, steel, wrought iron and malleable and non-ferrous tube fittings for gas, water, steam, oil, &c. The exhibit includes screwed, welded, or solder—capillary tube joints for all purposes.

The **Stanton Ironworks Co., Ltd.,** have two stands, indoor and outdoor. The former shows Stanton spun iron pipes, special castings, concrete-lined iron pipes, three types of flexible joints for gas and water mains, and a range of pig-iron. Historic pipe exhibits and a demonstration of flexible joints under pressure are included. The outdoor stand contains primarily concrete products such as lighting columns.

Staveley Iron & Chemical Co., Ltd., exhibit products in three categories—sand spun and metal spun cast iron pipes for gas, water and steam, pig-iron for general founding and forge purposes, and chemicals. The latter include acids, coal tar products, sodium chlorate, liquid chlorine, and a preparation of 'Glacia' salt from brine, together with the many applications of salt in industrial processing.

The Steel Equipment Co., Ltd., shows a selection of the modern steel storage equipment including adjustable shelving in a double-tiered stack with open type flooring, approach stairway, &c. One of the most interesting developments is a clothes locker which is claimed to be practically pilfer proof. Other products on display are bins, work benches, counters, and the well-known tilting barrel stand.

John G. Stein & Co., Ltd., exhibit refractories for all purposes, including firebricks, silica bricks, magnesite, chrome-magnesite, and chrome bricks, and high alumina refractories, &c. A special exhibit is of chrome magnesite bricks in open hearth furnace construction, in the form of a full-scale model of a section of an open hearth roof and uptake.

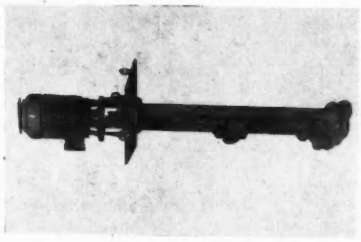
Stelcon (Industrial Floors), Ltd., have on the floor of their stand 'Stelcon' anchor steel plates, which are dustless and able to resist heavy and concentrated traffic. Samples of 'Stelcon' storage wall units are also available for inspection. These provide a new, simple, and efficient method of storing bulk materials. The walls are composed of independent self-supporting units made of reinforced concrete to a special design. No bedding down is necessary; they are simply laid on level ground and can be loaded either or both sides.

Stewarts & Lloyds, Ltd., occupy three stands—in the engineering section, the building section, and an outdoor stand. The former shows steel tubes and fittings for the conveyance of steam, air, water, &c., tubular steel coils, protective linings and sheathings, rolled steel strip, coal mining equipment, and foundry and basic pig irons. The building section stand is devoted to gunmetal valves and fittings for steam, water and gas. The outdoor stand contains the four main types of tubular steep lighting columns.

Sumo Pumps, Ltd., have an attractive stand which is devoted to the firm's well-known submersible pumping units for use in agriculture, domestic and public utility water supplies. These multi-stage centrifugal pumps are mounted directly on to submersible squirrel cage motors suitably wound for A.C. supplies.

Thomas & Bishop, Ltd., exhibit their well-known range of 'Flexo' products, including belt treatment, tinning compound, furnace cements, jointing paste, kneadable metallic packing. Also shown is 'Tebeon' roofing compound and 'Permac' jointing material.

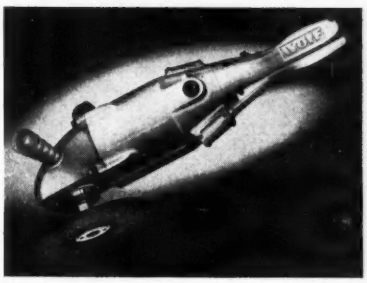
Richard Thomas & Baldwins, Ltd., exhibit two complete ranges of products—one in steel and one in aluminium. The former includes flat rolled steel products, sheet steel, tinplate, and stainless. Electrical grades are also shown, together with light alloys. Aluminium and its alloys appear in slabs, plates, sheets, circles, roofing, rainwater goods, and presswork of various kinds.



A typical Sigma vertical glandless acid pump, type WA-N, fitted with intermediate bearing.

James Walker & Co., Ltd., have an excellent display of packings and jointings for every mechanical application, including the well-known 'Lion' brands. There is also a special display of 'Metaflex' stainless steel and asbestos edge wound gaskets for high pressure steam.

Thomas W. Ward, Ltd., and a number of subsidiary companies have two stands, one indoor and one out. The indoor stand displays photographs of those aspects of the group's operations which cannot be exemplified by actual machines or equipment, such as factory planning and installation work, industrial dismantling, shipbreaking, scrap handling, railway constructional work, erection of structural steelwork, roadmaking and the like. On the outside stand exhibits include sheet metal working machinery, woodworking machinery; pumps and compressors, and various items from the 'Polford' range of foundry plant. A crab for a 5-ton overhead travelling crane is also shown.



A new model 7-in. horizontal sander by Wolf Electric Tools, Ltd.

Wellington Tube Works, Ltd., exhibit a selection of tubes, tubulars and fittings, and a considerable range of products incorporating tubular construction, including an interesting handrailing joint. Examples are also displayed of fabricated flanged pipework for pressure purposes, together with panels specially designed for panel heating and a representative selection in the sizes 1-4 in. mild steel spiral wound gilled tube. 'Weldex' heaters are exhibited, of capacities varying from a small unit heater to a heavy duty Plenum, including a gas-fired unit heater for space heating.

Widnes Foundry & Engineering Co., Ltd. also have indoor and outdoor stands which exhibit the firm's range of specialised castings and fabrications in steel for the chemical, oil, food, and allied industries in ordinary and special irons, and in mild and stainless steel.

Wolf Electric Tools, Ltd., exhibit a complete display of electric portable drills, screwdrivers, grinders, polishers, sanders, blowers, chisel mortisers, hammer kits, a range of engine reconditioning equipment including valve seat grinders and valve and engine servicing kits, valve refacers, and the 'Mobilectric' engine workshop and electric solder-guns. New introductions to the B.I.F. are the latest 4-in. hand grinder and the 7-in. horizontal sander.

The Yorkshire Copper Works, Ltd., show examples of underground gas and water pipes which have been exhumed for inspection. In addition to the well known range of 'Yorkshire' fittings, the range of fittings in 3-in. and 4-in. sizes is exhibited with tools for assembling the fittings on the site. Refrigeration tubes are also displayed, and a new type of wrapping is shown in moisture-proof celophane with a final wrapping in 'Crepe Kraft.'

News in Brief

Tar Works Fire.—Extensive damage was caused by a fire at the works of the Scottish Tar Distillers, Ltd., Camelon, Falkirk. The fire, which originated in the naphthalene plant, comprising two adjoining buildings, was believed due to a faulty electric cable.

Leven Valuation.—Because the rateable value of Leven gasworks has been further reduced by £5,856, Leven Town Council decided on May 5 to join other local authorities who are to employ King's Counsel to fight their case in the Court of Session.

Miners' Demands.—A warning of a possible fuel crisis in three months' time unless the miners' demands for more wages, better holidays and conditions were met was given by Mr. Arthur Horner, General Secretary of the National Union of Mineworkers, when he spoke at the Scottish Miners' fourth annual gala day in the King's Park, Edinburgh. Mr. Horner said that if there was a crisis through the lack of manpower in the mining industry, those who had refused to make mining sufficiently attractive should accept responsibility for the consequences of their policy in this direction.

Chemical Research Laboratory.—The Chemical Research Laboratory, D.S.I.R., at Teddington, Middlesex, is to hold a series of 'Open Days' on June 28 (afternoon), June 29 (afternoon), and on June 30 (morning and afternoon). The afternoon of June 28 has been set aside for representatives of industrial firms who have not previously received invitations and the Director would be glad to receive applications from firms up to June 19. It is not necessary for those invited in previous years to re-apply. The main branches of research are corrosion of metals, inorganic chemistry, radiochemistry, organic chemistry, high polymers and plastics, and microbiology.

Increased Outputs in the North East

Shortage of Pipes

THE sixth meeting of the North Eastern Gas Consultative Council was held at Leeds on April 24, under the Chairmanship of Mr. W. Regan, J.P. Replies to questions asked by members of the council at the last meeting were given by the board. In reply to questions by Councillor H. J. Craven (Harrogate) and Mr. T. W. T. Hammerton (Hull) as to the percentage of total gas sold which is used for public lighting, and a further question by Alderman J. H. Whitaker (Todmorden) regarding the percentage of total gas sold which is used for industrial purposes, the board replied that it was not at present possible to give figures covering the whole of the board's area, as these figures were not available. However, they had found it possible to obtain the figures in respect of a selected number of towns and a chart was given, showing the percentages of gas used for industrial, street lighting, and other purposes in some of the main towns. In the course of the next two or three months when the board has completed a year's working, it will be possible to provide similar figures for the whole of the area.

In reply to a request for Alderman J. H. Whitaker that something be done to improve the position at Todmorden where street lamps were unlighted due to blocked services, the board stated that the matter had been investigated by the Deputy Chairman and a full report had been forwarded to Alderman Whitaker showing that at March 4 there remained seven lamps requiring attention. These were put in order during the following week and, as far as was known, the position was now satisfactory.

Commercial Appliances

Alderman **H. Hardy (Morley)** asked if something could be done to improve the pressure in kitchens at Morley Schools to avoid meals being provided late. He also stated that the gas charges booklet gave the price of gas for ordinary domestic consumers at Morley as 15d. per therm, whereas the domestic half-price tariff (limited to post-war houses) was given as 7.5d. per therm. Were ordinary domestic consumers in Morley subsidising occupants of post-war houses?

The board's reply was that this matter was taken up with the Group General Manager at Wakefield, who reported that there was no outstanding complaint of the nature referred to on the Morley books. An approach was made to the Director of Education, who knew that there had been some difficulty at the Gildersome cookery centre, but he did not attribute that to the gas supply, as he knew that a new 4 in. main had been laid last year, and he had no further knowledge of recent complaints.

A visit was then made to the manageress of the centre, who had apparently complained that a steamer was not working efficiently. The apparatus in this centre was not installed by the gas undertaking, and an inspection showed that the flames were not stable and the air controls were closed. The result was that there was an over-abundance of gas being used inefficiently. Arrangements were made to carry out temporary adjustments of the appliances and to effect a complete overhaul of the canteen equipment during the following week.

In answer to Alderman Hardy's question regarding gas charges at Morley, the chief accountant, at the request of the Chairman of the board, had produced a report on the effect of the charges at Morley, which revealed that the overall average consumption per domestic consumer in the Morley district in 1948 was 80 therms. The consumption per consumer in post-war houses was 119.2 therms. Although the half-price tariff consumer gained on his existing average consumption, he had a higher average than the normal domestic consumer, and only because of that did he receive any benefit. Under present prices the tariff consumer would pay more than the normal consumer if his consumption was under 85.5 therms per annum.

Alderman **Hardy** stated that since making the complaint regarding the gas supply, he had found that this was really due to old appliances and inferior fittings. Possibly it might also have been due to the local gas engineer not having a full knowledge of the particular appliances. He suggested that in future the services of the board's specialists should be sought for such complaints.

Replying on behalf of the board, Mr. **G. E. Currier,** Deputy Chairman, said that the services of all specialists employed by the board were available to all undertakings. Prior to nationalisation, said Mr. Currier, such facilities were only enjoyed by the larger undertakings, but now, under nationalisation, any of the undertakings, large or small, could call upon the board's specialists, and it was hoped that full advantage would be taken of their services.

Mainlaying Problems

Resulting from a question by Alderman G. H. Norton (Keighley) regarding a new main being laid in Marsh Lane, Keighley, Dr. **R. S. Edwards,** Chairman of the North Eastern Gas Board, explained that the cast-iron pipe position was the most difficult facing the entire gas industry. The demand for pipes with the advent of nationalisation over and above the quantities required for water schemes had made the situation acute. The matter was receiving the attention of the Gas Council. The board had to use the utmost ingenuity with the insufficient supply of pipes, and it was a case of the most difficult cases first.

A summary of manufacturing results, sales of appliances, &c., for the 11 months ended March 31 showed a total make of 28,668,317,000 cu.ft.(135,602,157 therms), an increase of 2.3% over the corresponding period of the previous year. A total of 92,366 meters had been fixed and 85,837 removed, a net increase of 6,529. The board had laid 8,516 new services and relaid 16,525; in addition, 150,274 yards of new mains had been laid and 12,726 relaid. There was a net increase of 52,897 in the number of appliances sold, including 26,671 cookers and 14,760 washing machines and wash boilers.

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150 Years of Printing

The world of printing has a history which may fascinate those who care to study it. The industry owes its strength to its undoubted readiness at all times to adopt the most modern methods of technique while retaining all that is best of the old; it is ripe with traditions of service established in printing houses that have been handed down from father to son through the years. Of such a nature is the firm of Straker Brothers, Ltd., which prints the *Gas Journal* and other publications at 194-200, Bishopsgate, London, E.C.2. Today we congratulate the Company on the occasion of its 150th anniversary, an event which has been marked by the publication of an illustrated book which in itself is exemplary of the craft of printing. Here the story is unfolded of the first years of the business when William Buck started work as a printer in the market town of Romford in 1800. The firm has throughout its 150 years remained essentially a family one. It was in 1845 that a partnership was developed between Charles, the son of William Buck, and Frederick Straker, who had married William Buck's second daughter. Since that time the firm has been wisely guided by members of the Straker family, and the review of its history over the past 100 years provides ample proof of the Company's vigour and resilience towards which the men and women behind the machines, whose work is described in an attractive pictorial tour of the works, have made no small contribution.

To mark their 150th anniversary the firm held a dinner at the Abercorn Rooms, London, E.C.2, on Friday last, to which some 350 members of the firm and guests were invited. The toast of 'The Firm' was proposed by Mr. H. H. Hammond, who retired in 1948 after 53 years' service, and the response was by Mr. Stanley Straker, Chairman of the Company. Mr. Graham F. Straker followed with the toast of 'The Visitors,' and Mr. E. Glanvill Benn and Mr. G. G. Eastwood replied. An entirely unexpected event followed. With a few well chosen words Mrs. C. Moore, who has been with the firm for 51 years, presented the Chairman, Mr. Stanley Straker, with a suitably engraved silver salver from the combined Chapels of the works. An enjoyable evening terminated with a first-class cabaret.

W. H. Dean and Son, Ltd., have removed from Hornsey Road, N.7, to larger premises at Dukes Road, Western Avenue, London, W.3, near Park Royal Underground Station (Telephone: Acorn 2289).

OPERATION EFFLUENT*

By PHILIP WEDGWOOD, B.Sc.,
Production Engineer Watford Division, Eastern Gas Board.

PART I.

IN recent times we have all heard a great deal about the disposal of effluents from gasworks. Some of us have been involved in difficulties arising out of particular aspects of the subject. Many more might be said to be trembling on the brink of troubles of one kind or another. These problems are becoming more pressing than ever before because under recent Acts of Parliament it has become necessary for everybody who is concerned with trade effluents, the treatment of sewage, and water supplies to comply with the law as laid down in the several Acts relating to rivers, the latest of which are the River Boards Act of 1948, the Public Health (Drainage of Trade Premises) Act of 1937, the Gas Act of 1948, and the Water Act, 1945. It behoves every one of us, whatever his position or the degree of responsibility resting upon him, to do all he can to deal with all effluents from a gasworks in a proper manner.

My first reaction when it was suggested I should read a paper on effluents was not entirely favourable because this ground has been covered so many times before. On second thoughts, however, I changed that opinion for a number of reasons. First, our President asked me if I would do it, and that indicated a desire for more information and further discussion of the subject, and the President's wish is almost a command. Secondly, nearly all the earlier reports and papers have been presented by chemists who have treated the subject in their own way. The membership of this Association is made up for the most part of engineers and managers of medium sized and small works who have to tackle their own problems and overcome local difficulties themselves in a way rather different from the manner in which they can be approached in large undertakings which have chemists on the staff. Thirdly, being a peculiar kind of chemist myself I might be able to treat the subject from rather a different angle and make a direct appeal to the works man—who is really the most important man concerned in the business because he gets the work done. That is the keynote of this paper—getting on with the job without the loss of any more time. It must be realised now that we are really up against a very serious problem in a very large number of gasworks, not only in this Eastern area, but over the whole country.

Stated simply this problem is to deal with all questions involving the use of water and steam on the works properly, and to dispose of the waste waters, including ammoniacal liquor, in the right way. When we have achieved that happy state of affairs our works will be more efficient than they are today. To improve the efficiency is one of our main objectives. None of the problems is new, and so far as liquor effluents are concerned other folk have looked askance at gasworks ever since the first gasworks was built. For example, when Clegg Senior built a gasworks for Mr. Ackerman in the Strand in 1812 there were such complaints that a fear was entertained of its having to be discontinued. Ever since that time there have been more or less serious complaints about killing fish in rivers, the pollution of water supplies through liquor going into the ground, smells arising from streams and ditches, and so on. All the dubious practices which have caused this sort of trouble must be discontinued. Let us think for a moment of what is still being done in many places; we are wasting ammonia, throwing it away at risk of giving offence to other people when there is a demand for fertilisers to increase production of home grown foodstuffs. We have no right to waste anything obtained from coal, our most valuable natural asset. It grieves me to think of it, particularly when on some special occasions we proudly show those wonderful charts, or pretty pictures of a tree, illustrating what the gas industry can produce from a lump of coal. A reply might be that to recover it does not pay. That is not a complete answer. It may even become necessary to pay for the privilege of discharging it to waste. The point is that that ammonia has been produced and it can be worked up into a saleable product. It should not be forgotten that the manufacture of synthetic ammonia requires the expenditure of capital on quite extensive plant and the use of fuel. Surely we should today be able to say that we have advanced since 1841 when Clegg wrote his treatise on the manufacture of gas. Speaking of ammoniacal liquor he says 'it is collected and sold to the manufacturers of ammoniacal salts, *or otherwise disposed of*.'

A Matter of Reputation

Even in those days they tried to do something about it, because later on in that treatise he says 'the ammoniacal liquor is either evaporated in the cast iron pans placed under the furnaces for that purpose, manufactured into the carbonate and muriate of ammonia, or used as manure.' In this there is a good example of history repeating itself. We have heard of these things again recently. Evaporation by this method is a very unsatisfactory process. Apart from the inconvenience and messiness of the job there is still the possibility of fresh objections being made to the practices of 'those gas people,' because the products are all discharged into the atmosphere and pollution of the atmosphere may lead eventually to action by the Alkali Inspector or the local sanitary inspector. Where liquor is discharged into the sewer complaints may arise from time to time from the local authority's surveyor or the sewage works manager. Even where spent liquor is discharged under some kind of control, complaints have been made if the effluent from the sewage works is not up to standard, often with the comment that the gasworks is the cause of the trouble because 'they put a lot of liquor down the sewer.'

In short, nobody likes gasworks effluents, and nearly everybody takes every opportunity he gets to let us know it. Our objective now—the objective of every one of us—must be to bring about a change in that attitude. Let us resolve now that if in any place offence has been given, we will remove the cause of it. Fortunately we have some friends on the other side of the fence who understand our difficulties and will help us to surmount them. Let us hope that in course of time—and we should not be too long about it—we will be able to take down that fence so that we can all work together in harmony.

Let us face the fact that has been obvious for a very long time, that in this matter the gasworks has a bad reputation, deserved in some cases but not in others. We must remember that there is always a tendency for the other man, who does not see our side of the picture, to think and sometimes to say that we are all tarred with the same brush.

PART II

In this part of my paper I propose, in the first place, to delve into ancient history. When tackling any subject, new or old, I find that it is most instructive and it nearly always gives a lead to the problem in hand. The history of this subject is by no means new to me, having been born with coal dust in my blood and brought up with the Bible in one hand and the 1909 edition of Lunge's 'Coal Tar and Ammonia' in the other.

* Paper to the Eastern Association of Gas Engineers and Managers, Felixstowe, May 5, 1950.

At week-ends these somewhat heavy tomes were changed for the *Gas Journal* and the *Iron and Coal Trades Review*. I am thankful now that I was also sent to a school where the Head did make a point of trying to teach his pupils how to think.

Should we who work in this industry today be surprised to find that in 1883 J. H. Cox, at a meeting in Leeds, gave a paper and Lunge refers to that and others, notably by L. T. Wright (J.S.C.I., 1886), quoting numerous analyses and certain conclusions which are quoted:—

1. The percentage of fixed ammonia will be influenced by the temperature of the gas retorts, by the temperature to which the gas liquor has been exposed, by its exposure to air (which oxidises the sulphide into thiosulphate and perhaps higher than that) and by the general methods of washing and scrubbing the gas.
2. The oxidising action of the air is also of great influence on the gas liquor. If air is mixed with the gas before washing out the ammonia, the percentage of not easily decomposable salts in the gas liquor is increased by the oxidation of the sulphur compounds.
3. Virgin gas liquor from the first parts of the plant may contain free ammonia, but in passing through the scrubbers enough CO_2 is absorbed to convert all the free ammonia into carbonate.

Complete analyses were given of liquor from different parts of the condensation and washing plants when Linder came into the picture with all the work reported in the Alkali Reports in the early years of the present century.

Mayer and Hempel (1908) also studied gasworks liquor in detail and showed that 'the liquor in the well contains but a very small quantity of free ammonia (0.102 gr.), but that in the hydraulic main the considerable amount of 1.043 grammes per litre owing to a far going dissociation of the carbonate and sulphide.' That was important, and I return to the point later.

Incomplete Research

All this work was done thoroughly and well, but it is unfortunate that, in common with the majority of papers and reports published since that time, it was incomplete. It seems strange to me this should be so. Is it because where samples could be taken and analysed most carefully it was not possible to measure the quantities of liquor produced, and *vice versa*, or did nobody think of the fact that it is most important to know the volume and composition of the mixed finished liquor? I am most anxious to press this point because in my opinion it has been a major defect in some more recent investigations and I fear that some of the conclusions on which many people rest today are 'not proven.'

It was in 1907 that Frankland and Silvester determined the 'oxygen absorbed' values of thiocyanate, thiosulphate, and phenol, based on the four-hour test with permanganate at 27° C. and determined the factors which have been used ever since in calculating the O/A due to these constituents in liquors, and the 'difference figure' derived therefrom. It is a pity these values are not absolute because such a large proportion of the total O/A figure of a liquor includes some items of which we have no information at all, and all the errors and uncertainties of some of the analyses and empirical calculations.

We find the same sort of thing still applies to the methods of evaluating the strength of sewage, and until some way of determining the real load on sewage treatment works due to sewage and the trade effluents added to it is found, I feel that no scientist connected with this work should rest content. After all, if we need a bigger and better bomb to destroy an enemy more efficiently than it was ever done before the job can be done very well. Is this other job more difficult than that? There does not appear to have been any great advance made since the Royal Commission's Report of 1913.

The next work of real importance was reported in the Alkali Inspectors' Reports in the early 1920's, and in 1923 very complete figures were given for liquors from vertical retort and horizontal retort installations. In this report there is particular reference to the 'united liquors' which are made up by the mixture of condensates and scrubber liquors from the various parts of the plant to dephenolation in towers to reduce the 'oxygen absorbed' figure, and biological treatment of effluent by filtration through matured coke. It was also recommended that air for purifiers should be put in under pressure at the purifiers and not on the vacuum side of the exhausters, to minimise the production of thiocyanate and thiosulphate, and also to isolate the condensate from purifiers.

The main difference between these liquors is brought out in the following results extracted from the tables :—

Liquor	*Horizontal Retorts*	*Vertical Retorts*
Oxygen absorbed, parts per 100,000 (excluding H_2S and HCN) ...	610	1130
Phenol (calculated as C_6H_5 OH) grammes per 100 cc.	0.162	0.327
Higher Tar Acids (estimated as $C_6H_4(OH)_2$) grammes per 100 c.c ...	0.040	0.385
Oxygen absorbed (parts per 100,000):		
Due to phenol	290	580
Due to other forms (including higher tar acids) by difference	65	330

Here I would like to point out two things of interest. First, there is twice as much phenol in the vertical retort liquor, and if the 'higher tar acids' figure is reliable as a guide to their real quantity, nearly 10 times as much as in the horizontal retort liquor. The 'difference figure' is attributed to 'other forms (including higher tar acids).' It is only five times as high in the vertical retort liquor as it is in the horizontal liquor. In the former it represents about 30% of the total of the O/A values of the constituents, excluding only sulphide and cyanide.

The Institution of Gas Engineers set up its first committee to deal with these ammonia liquor problems in 1926 and since then we have received their reports, the research work having been carried out by Drs. Parker, Monkhouse, and Key, in that order, with the assistance of others. Parker presented a short report covering processes and he dealt with certain aspects of items connected therewith, and a programme of work was proposed. With the subsequent work we are all fairly familiar. It was in the discussion on the Sixth Report in November, 1936, that Dr. Parker said 'a stage now seems to be reached at which a report or brochure summarising the present position and the results of the Institution's work on effluents might be prepared. Such a brochure might serve not only as a guide to engineers in selecting the best practicable methods for particular circumstances, but also as *a useful new starting point for further investigations.*'

Works of Reference

In 1938 Dr. Key produced his very excellent book 'Gasworks Effluents and Ammonia,' in which he did a good job by reducing a colossal amount of printed matter into a convenient and easily digestible form. I would make three comments here. Instead of being the starting point for new investigations, that book was the cairn marking the spot at which the exploratory journey stopped. As you know it was reprinted recently in its original form with some further references added by Dr. Blackburn. My second comment—that it has been generally accepted as a standard book of reference on the subject. I have had certain opinions expressed and conclusions recorded therein quoted as authoritative evidence against me. Thirdly, its title is all embracing in respect of gasworks effluents, whereas it does, in fact, deal only with ammoniacal liquor effluents and ammonia.

Regarding the first point, and in particular with certain parts of the book, I think we should study it in the light of Dr. Parker's suggestion. No doubt the war was largely responsible for not going on with some further investigations. My reasons for making the second comment perhaps will be understood a little later on. Regarding the third point, is there not a crying need for a good book on the whole subject of gasworks effluents? It is something I have considered for

years, but I have never had time to do more than think about it. If anyone would tackle that job, I for one would be pleased to co-operate with him. In my opinion we have concentrated on ammoniacal liquor effluents to the extent that the importance of other effluents from gasworks has been ignored. Liquor effluents are not the only ones for which we may have to pay in some places.

Next I propose to draw attention to some points in the Institution's reports, and here maybe I am being deliberately provocative to stimulate discussion of certain aspects of our work. Often it has been suggested that retort house circulating liquor containing little free ammonia, with or without some condenser liquor from the hot end, should be used for final stage washing after it has been cooled. This is too big a subject to discuss in detail here, but Colonel Carr gave some figures from Stretford where it was claimed to be working well, in the discussion on the Third Report of the Ammonia Sub-Committee (1930/31). The average strength of the finished liquor to loading tank was 13.78 oz. total and 6.23 oz. free ammonia. Fifty-five per cent. of the ammonia was present as fixed ammonium salts. That is not a good liquor for distillation. No analyses were given but it would have been interesting from the effluent point of view. The ammonia at inlet to the 'secondary' washers was given as 211 gr./100 cu.ft. Assuming a make of 14,000 cu.ft./ton of coal, this is equal to 4.2 lb. of free ammonia per ton of coal. On the other hand, again making an assumption that the volume of finished liquor would be 20 gal./ton, there being no water added in washers, the free ammonia yield was only about 2.7 lb./ton of coal, a very poor figure. Did the balance disappear by conversion into objectionable oxygen absorbing fixed ammonia salts?

Hot Gas Detarring

I turn next to hot gas detarring. How many times has this been recommended as a solution of difficulties? Instead of being a matter which has been satisfactorily disposed of, it is in my opinion, a highly controversial subject. I am not in favour of the installation of electro-detarrers on the inlet side of the exhausters in gasworks, unless we are prepared to adopt the direct recovery process for ammonia extraction. This might be considered for new large works—as installed on some coke oven plants. In such cases the treatment of the effluent would not be a problem. Is any real benefit derived from hot gas detarring in gasworks equipped with conventional condensing and ammonia extraction plant? In the first place the O/A of the finished liquor is increased substantially due to a higher phenol content and present proposals for payment for effluents are based on O/A figures. In the second place I would refer to some figures published in the reports.

In the case of Coventry (Fifth Report of the Effluents Sub-Committee 1930/31) where there was a cyclone tar extractor, results are given in Table VI which show reductions in higher tar acids in crude liquors and spent liquors taken over two periods (part of which may be attributable to having less vertical gas in the second period). There is also a reduction in total O/A and phenol which suggests larger volumes of liquor in the second period. The O/A of the effluent in Period I was 900 and in Period II, 714. If 0.5% is put into sewage having an O/A figure of 13, the new figures for the mixtures would be 17.5 and 16.6—a difference of only 5%—which I suggest is relatively unimportant. The O/A value is not an absolute indication of the amount of work to be done at the sewage works, and my personal view is that spent liquor of reasonable quality is not a difficult thing to treat in a normally efficient sewage treatment works.

In the following year (1931/32) these tests are referred to again and it is said that 'this early separation and segregation of the vertical retort tar from the main bulk of liquor caused the oxygen absorption of the spent liquor from the still to be reduced from 900 to 714 parts per 100,000, a reduction of 24%' (this should be 20.6%!). Analyses showed that the reduction obtained was in the higher tar acids—the colour producing bodies, the difference figure being reduced 48%. As regards these 'higher tar acids,' or more correctly as it is shown in the Analysis Table 'other bodies (by diff.),' we must remember that this item is the sink for some unknowns and all the errors, besides tar acids. But Table III gives the quantities of effluents also, and I find them interesting because in Period I there was an average flow over 12 months of 620,000 gal. per month, and in Period II an average over the nine months, which are given, of 757,000 gal. per month—an increase of 22%. The O/A figures given are 965 and 759 respectively, showing a decrease of 21%. Thus there was no reduction in O/A load for the sewage works, but there was a substantial increase in the volume load.

Hinckley Investigations

Referring to the Hinckley investigations I would raise two points which I consider important. Monkhouse found that with the detarrer in operation 1.4 gal. of tar came down the condensers with a specific gravity less than 1 (Fifth Report, Table III, 1930/31).

Retort house to annular condensers ...	0.1 gal. at 0.952
Annual condensers	0.5 „ „ 0.914
Annular condensers to water condensers	0.6 „ „ 0.900
Water tube condensers	0.2 „ „ 0.892

We should not overlook this point. Britton has reported (1945) that the volume of this light oil is from 1.5 to 2.0 gal./ton of coal. This will float on top of the liquor in the wells and may very easily find its way to the ammonia liquor still and the sewers unless some special arrangements are made to avoid that happening. I have had some experience of this and the results can be unpleasant. The other point came to mind when Badger's survey was presented to the Institution last November; I could not be there so I will ask the question now. Does the analysis given on page 16 represent the still effluent of all the liquor produced on the works? I ask because the thiocyanate and thiosulphate and polyhydric phenols are so low. I am very anxious that we should all get these published results in correct perspective. Not only are we expected to act upon recommendations which are made, if an improvement can be effected, but the other parties in this business of effluent disposal are often inclined to think, having maybe only read abstracted reports, that we are not as helpful as we might be if we don't do something that they may have been led to think is easy—that is putting it mildly.

Treatment at Sewage Works

The next subject I would like to discuss is that of the treatment of liquor effluents at the sewage works. Experiments were carried out at Leamington which were described in the Fifth Report (1935/36). Below are three Tables, constructed from data given in the tabulated results in the report, with an extra line added which I have called 'efficiency of beds':—

Parts per 100,000.

	Blank	*Spent Liquor*	*Crude Liquor*
From Table 14 with 0.25% in sewage			
O/A of feed	3.45	4.46	4.59
O/A of effluent	0.79	0.90	0.98
Efficiency of beds % ...	77.20	79.80	78.50
B.O.D. (5 days) of effluent	0.81	0.95	1.18
From Table 15 with 0.5% in sewage.			
O/A of feed	3.43	6.93	9.30
O/A of effluent	0.78	1.08	1.21
Efficiency of beds % ...	77.40	84.50	87.00
B.O.D. (5 days) of effluent	1.09	1.67	2.96
Dose of liquors from chlorine content % ...	—	0.50	0.61
From Table 16 with 0.5% in sewage.			
O/A of feed	2.55	6.19	10.00
O/A of effluent	0.63	1.16	1.39
Efficiency of beds % ...	75.00	81.30	86.10
B.O.D. (5 days) of effluent	0.59	0.92	1.38
Dose of liquors from chlorine content % ...	—	0.48	0.65

It would appear that despite a higher loading, the efficiency

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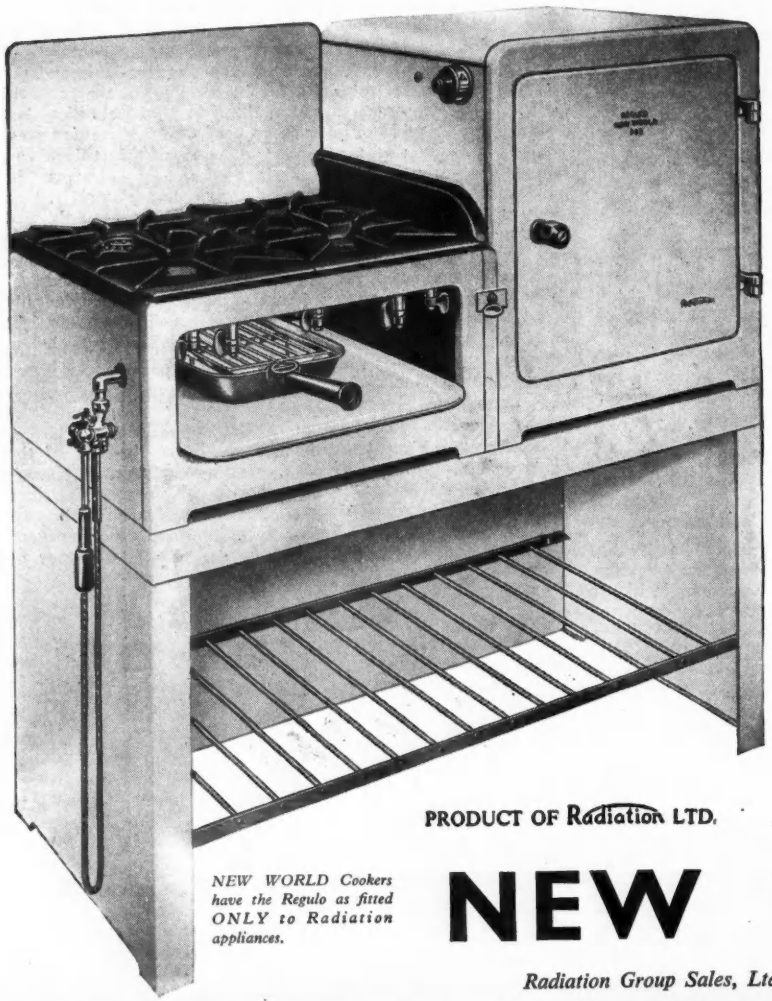

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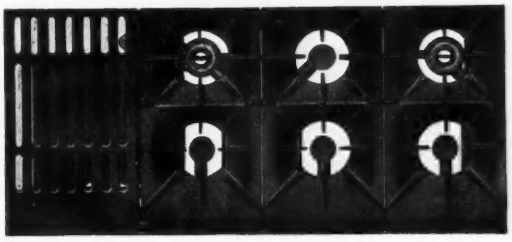

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of the filters is higher in every case, as judged on O/A removal, when liquor is present. Does not this indicate that liquor is not a difficult thing to treat, but rather that it may be oxidised even more rapidly than the sewage constituents? This point I do want to stress. In the discussion on the Fourth Report (1934-35) Mr. O'Shaughnessy, who is an expert on the sewage side, made an interesting comment which I will quote: 'Dr. Key again confirms the ease with which the oxidisable impurity in liquors rich in phenol may be reduced. This is due, as he has shown, to the ready amenability of phenol in dilute mixtures with sewage to biochemical destruction under aerobic conditions. This is a particular example of a more general finding that when a *non-nitrogenous fermentable material* is mixed in appropriate amount with the fermentable nitrogenous matter of sewage the biochemical activity of the mixture is greatly stimulated as against that of the several constituents alone.'

It will be noticed that when the liquors are present the O/A figures of the treated effluents are higher than when sewage was treated alone. A considerable amount of work was done in small laboratory filters which is found in the reports of 1933 to 1935-36 in which Key showed that there was an 'O/A residue' which he attributed to 'higher tar acids.' I suggest that there may be at least a contribution to that which is made by some other constituents about which we have no information at all up to the present. Do the tar bases come into this picture? Can we be sure today when we contemplate hot gas detarring, which is quite an undertaking, we are doing all that is necessary to solve the problem? After all, it is something very small that we have to pin down in order to account for only 1 or 2 units of O/A or B.O.D. in a final sewage effluent. It would be very interesting to know if this O/A residue persisted at Hinckley, for example.

Rate of Discharge

As a result of this work it was concluded that gas liquor constituents were oxidised, in respect of rate, in the order, phenols, higher tar acids, thiosulphate, thiocyanate. With that I would agree, and having that in mind it is pleasing to know that 'a bacteria bed, originally unable to purify thiocyanate in a concentration of 2 parts per 100,000 became capable of *completely* oxidising a solution 40 times as strong.' *The really essential thing is to supply to the beds a constantly proportioned mixture of sewage and spent liquor.* Sewage itself contains small concentrations of phenols and thiocyanate and the beds must become acclimatised gradually to bigger doses of any particular constituent. What would happen to a man who regularly enjoyed a pint of beer every day and suddenly changed his liquid refreshment to a pint of whisky? It is the same sort of thing. And as to the rate at which effluent may be discharged to the sewers, I would like to quote again, this time from the Second Report of the Liquor Effluents and Ammonia Sub-Committee, 1932-33:—

> 'The Committee was fortunate in being able to report the work of Mr. F. R. O'Shaughnessy on the purification of sewage which contained spent liquor (Fourth Report of the Liquor Effluents Sub-Committee). It was found that at Cheltenham up to 1%, or more than twice the average rate of production, of spent liquor could be added to the sewage without serious deterioration of the effluent from the sewage disposal works. It was considered important that the liquor should be added regularly, and not in flushes. This point is rightly insisted upon by many sewage works managers.
>
> 'It does not necessarily follow that the results obtained at Cheltenham are applicable to other works, since so many different conditions may operate. Each works, therefore, should be considered as a separate problem. It is a fact, however, that spent liquor is being treated at many sewage disposal works to the satisfaction of everybody concerned. The Committee feels that much could be accomplished by closer co-operation between the industry and those in charge of sewage treatment works. With this in view a paper has been read by Dr. A. Key at a meeting of the Midland Section of the Association of Managers of Sewage Disposal Works. A summary of the paper is given in Appendix (2). A lively and sympathetic interest was shown by members of the Association.'

Phenol and Tar Acids

I would add that my own experience confirms this. In one case of which I have knowledge a discharge of 0.75% of the average daily flow of sewage is regularly maintained, the flow being varied during the day at the gasworks to keep the proportion constant. The sewage works is very much overloaded and in all the circumstances the results obtained are fairly good. I think you will be interested to know that only a trace of thiocyanate (less than 0.2 parts per mill.) is found at times, when the treated effluent does not quite conform to Royal Commission Standards. Now that a reliable test is available for the determination of thiocyanate in particular, I consider that every effort should be made in investigating the processes in a number of sewage works under controlled conditions to improve our knowledge and satisfy ourselves and the sewage disposal authorities that gasworks effluent treatment is not something to be feared, or to which any objection should be raised in respect of its acceptance into the sewers.

> We know it is possible to reduce the O/A of liquor by:— distilling it to remove free ammonia, H_2S and HCN, and minimising the production of thiocyanate and thiosulphate by having proper liquor circulating and washing systems and not having oxygen in the gas.

It remains to take another look at the phenol and higher tar acid question. If others are prepared to agree with me that hot gas detarring gives comparatively small benefits in return for higher costs and more trouble on the works, there is only one thing we can do—that is, simply not to make them in large quantities! Perhaps it will be useful and informative to many engineers to put together some data on this subject which are available.

These phenolic bodies might be visualised as parts of the coal substance, which is decomposed and split up into simpler bodies by the action of heat. At a low temperature they are complex. At higher temperatures they are themselves broken down into simpler compounds. Passage over hot coke and retort surfaces aids the decomposition until one arrives at benzene, the simplest aromatic hydrocarbon, which is a six-cornered ring with a carbon atom and a hydrogen attached to it at each corner. Phenol is the simplest of the tar acids, having an OH group at one corner of the benzene ring instead of an atom of hydrogen. Catechol has two OH groups, and the 'higher tar acids' are just bigger and more complicated variations of the same sort of thing. To get the maximum coal gas yield from coal we need the most efficient cracking conditions in the retort, and so the yield of liquid products is reduced by cracking, to produce hydrocarbons and hydrogen in gaseous form. Evan's Cantor lectures in 1924 dealt with this matter in a really beautiful way. Nearly all the tar acids which are made in the retort are found in the tar, only a small proportion appearing in the liquor.

Low Temperature Results

When coal is carbonised at low temperature (600-650°C.) about 20 gal. of tar per ton of coal are produced. This low temperature tar and the phenols contained in it were described by Bristow in 1947 (J. Inst. Fuel). Forty-eight per cent. of the coal oil, which itself represented 9% of the weight of the coal, was soluble in alkali. Of this 32% was recovered by distillation and 16% was left behind as pitch. The recovered crude tar acids—that is, the 32% only—represented, therefore, 64 lb. of tar acids per ton of coal.

Some other figures given in the paper are useful to illustrate the 'cracking' aspect. Originally they used pot stills to distil the tar, but later changed over to tube stills to obtain greater efficiency and reduce the loss of oils caused by decomposition.

Fraction.	Distillation carried out in: Pot Still.	Tube Still.
Light oil	6	2
Middle oil	16	38
Heavy oil	36	30
Pitch	37	25
Water and losses	5	5
	100	100

The pitch was reduced by 12% and the heavy oil by 6%. There was two-and-a-half times as much middle oil. This middle oil was mainly phenols and cresols.

The ammoniacal liquor contained 1% of dissolved phenols. Of this quantity, monohydric phenols represented 65%, dihydric phenols 29%, and 6% was left behind as pitch formed on distillation, the composition being as follows:—

	%	
Phenol	28.0	
o—cresol	3.5	65%
m & p cresol	21.0	
xylenols	12.5	
Crude catechol	16	29%
Crude resorcinols	13	
Pitch		
Phenol	28.0	6%
		100%

This is the most complete information which has been published so far regarding the phenols in liquor, and it must be remembered that it is the result of low temperature carbonisation of coal.

Yield of Tar Acids

It can be expected that continuous vertical retort tar and liquor will also contain large quantities of tar acids because little cracking takes place in the retort, particularly at high steaming rates when producing low calorific value gas. In Key's book, on page 10, he gives analysis of two vertical retort liquors showing nearly 0.4% of monohydric phenols alone. I have had analyses showing 0.9% total tar acids, including 0.37% phenols, where some horizontal retorts are in use alongside verticals, the ratio of coal throughputs being 1 to 2.

In horizontal retort liquor from two works the corresponding figures were 0.53% total tar acids, including 0.35% phenols. Thus the higher tar acids were 0.53% in the former case and only 0.18% in the latter. If we take the volumes of liquor into account and turn these figures into quantities per ton of coal we get in the case of:—

(a) The vertical/horizontal retort (2—1) mixture at 40 gal./ton
1.48 lb. of phenols
and 2.12 lb. of higher tar acids

(b) the horizontal retort liquor at 34 gal./ton.
1.2 lb. of phenols
and 0.6 lb. of higher tar acids.

Thus we find that there is 3½ times as much 'higher tar acids' in the first case than the second. The concentration of these things in a liquor, shown by the analysis, only tells part of the story.

The yield of tar acids is also dependent on the kind of coal used. For example the following table is made up from figures given in the paper on the Woodall-Duckham static verticals to the Institution in 1938-39.

Coal	Crude Tar Acids. As % of dry tar. In oils 200-270°C.	Equivalent to lb./ton of coal.
Durham run of mine	3.2	4.6
S. Yorkshire screened	4.9	7.1
Notts. screened	6.4	9.5
Scottish feebly coking doubles	6.4	10.0

From the same paper and the paper on the Westvertical plant given to this Association in 1942, the following figures are built up to show the variation in tar acids in the tar produced in different carbonising plants, all using South Yorkshire coal.

Type of Plant.	Crude Tar Acids. As % of dry tar. In oils 200-270°C.	Equivalent to lb./ton of coal.
Coke ovens	3.0	3.6
Westverticals	4.4	6.3
Static verticals	4.9	7.8
Continuous verticals	10.0	21.5

All these figures illustrate the situation in which we find ourselves when we have to decide on new carbonising plant, and perhaps would prefer continuous vertical retorts for various reasons—but have a difficulty in disposing of the liquor effluent!

PART III

On the subject of ammonia extraction on gasworks one can say either a lot or a little. To deal with the subject properly would require a book. There are, however, a few things to which the attention of every works engineer or manager can be directed, and if our knowledge is applied it can bring about a useful result because:—

(a) If his plant is good enough and it is operated efficiently, he will know what amount of ammonia he should recover and how strong the liquor should be, or

(b) If his plant is inadequate for the job he will soon know what is wrong with it and he can ask for something better.

The first essential is really good cooling—and that subject calls for another book suitable for the average works man. The second essential is first class washing plant, preferably a Livesey washer followed by a multistage scrubber of some kind. For the sake of good oxide purification do not, on any account, let more than 5 gr. of ammonia per 100 cu.ft. of gas escape from the last washing stage. I would like that figure to be *nil*.

Sources of Information

There have not been many papers to which engineers could refer for data. There was the paper by Hollings to the Institution of Gas Engineers in 1928, and another by Cooper in the *Gas Journal* in 1943. From the information in these and some experimental results of my own (I.G.E. Thesis, 1928) the following broad principles can be laid down.

1. The temperature of the gas at the outlet of condensers must be brought down to the absolute minimum which is possible. It may be desirable to look into the question of better condensing plant on some works.

2. The quantity of virgin liquor produced—that is, all liquor except water added to scrubbers—must be as low as possible. Every 1% of moisture in the coal means 2½ gal./ton of virgin liquor. Every 1% of steam in vertical retorts which is not decomposed leads to the same result. Furthermore the steam used for this purpose unnecessarily is expensive to produce and needs more steam to distil the additional liquor made from it later on. The production of a lot of virgin liquor does not mean that less water is required in the scrubbers. The greater the amount of virgin liquor produced, the greater the total volume made, carrying larger quantities of undesirable oxygen absorbing constituents.

3. No liquor out of hot liquor circuit or from condensers should be used in the washing plant anywhere unless it is cooled down to gas temperature.

4. Even after cooling, none of these liquors is suitable for use instead of water in the final stage of extraction.

5. If ammonia extraction on a particular works is carried out in a number of vessels or stages in series, there will be some point in the system where cooled mixed virgin liquor can be put in to do some useful work by extracting more ammonia. This requires careful investigation beforehand and the data given later will be useful when such a proposal is under consideration.

6. The most important factor is the efficiency of the ammonia washers themselves, and this depends largely on the number of stages of washing and the adequacy of the plant from the point of view of size and washing surface. The quantity of water required depends more upon the volume of gas to be washed than the amount of ammonia in it, expressed as grains per 100 cu.ft.—and very important, the efficiency of distribution of this water over the scrubbing surface in the last stage of washing. Here we come up against a real difficulty on small works equipped with tower scrubbers, but even in these cases it is likely that improvements can be made without great alterations.

Now I will deal, in a little more detail, with the data which are helpful in considering these points.

Gas Cooling

Hollings determined the ammonia content of gas which contained also 3.5% of CO_2, in contact with liquor at different temperatures. The results are shown in Table I, which is derived from the graph in his Institution paper. If we were scrubbing with 6 oz. liquor at 60°F., with 3.5% CO_2 in the gas, we should have 18 gr. of ammonia left in the gas to remove in the next stage. At 70°F. it would be 32 gr., and a higher proportion of water would be required in the final stage also because the gas will be warm. The graph given in the original paper is very instructive.

With less CO_2 in the gas, as in the case of works with horizontal retorts, the temperature effect is greater.

TABLE I.

Ammonia in gas in equilibrium with	*Temperature °F.*				
	50	60	70	80	90
1 oz. liquor	2	3	5	9	17
2 oz. „	3	6	10	20	35
3 oz. „	6	10	16	30	55
4 oz. „	7	13	20	39	69
8 oz. „	13	25	43	80	140
12 oz. „	20	41	71	130	—
16 oz. „	30	60	103	190	—

(Table III Hollings and Pexton, 1929-30 extended.)

Table II shows the ammonia content of the gas in equilibrium with liquor of different strengths, the gas containing 1.8% CO_2. Analyses of the liquors also are shown and it may be stated that from a liquor analysis it is possible to calculate what the ammonia content of gas in equilibrium with it would be. There is no point in going into that in detail in this paper, but it can be done if it would be helpful in any particular case. For most practical purposes, knowing the CO_2 content of the gas, the ammonia content in equilibrium with scrubber liquors can be estimated approximately by comparing the 60°F. figures in Table I with the corresponding figures in Table II.

TABLE II.

Ammonia in gas in equilibrium with liquor	*Analysis of liquor*			
	Percentage			Ounce Strength
Grains/100 cu.ft.	CO_2	H_2S	HCN	of NH_3
5	0.55	0.17	0.06	0.30	1.4
10	0.95	0.20	0.05	0.52	2.4
20	1.50	0.40	0.05	1.00	4.6
30	1.95	0.50	0.05	1.30	6.0
40	2.35	0.50	0.05	1.60	7.4
50	2.70	0.50	0.05	1.80	8.3
60	3.10	0.50	0.05	2.10	9.6
70	3.45	0.50	0.05	2.35	10.8
80	3.75	0.50	0.05	2.55	11.7
90	4.05	0.50	0.05	2.80	12.9
100	4.35	0.50	0.05	3.00	13.8
110	4.65	0.50	0.05	3.20	14.7
120	5.00	0.50	0.05	3.40	15.7
140	5.60	0.50	0.05	3.80	17.5
160	6.20	0.50	0.05	4.20	19.3
180	6.80	0.50	0.05	4.60	21.2
200	7.30	0.50	0.05	5.00	23.0

(The above figures are approximate from smooth curves.)

The gas being treated contained (average figures):

NH_3	186 gr./100	cu.ft.
H_2S	740 „	„
HCN	88 „	„
CO_2	1.8%.	

Use of Virgin Liquor

It has been stated that this must be cooled before it is used for scrubbing. This is not the only difficulty involved. The chances are that owing to the high temperature at which it is deposited it has not been able to absorb CO_2 and H_2S to satisfy the ammonia in it. In weak scrubber liquors we find ammonium bicarbonate and bisulphide. In stronger scrubber liquors there are mixtures of the acid salts and the normal salts, the normal salts becoming predominant with increasing strength—in other words, as we move backwards in the ammonia extraction plant towards the retort house the proportion of ammonia in these salts increases. This effect goes on and is intensified as we go back through the condensers to the hydraulic mains, with the result that in the hottest section of the condensers and in the retort house circulating liquor there is very little H_2S, and not enough CO_2 to satisfy the ammonia. Consequently there is some really 'free' or uncombined or caustic ammonia in the liquor, and this has a very high vapour pressure.

The effect of this free ammonia on the equilibrium is illustrated in Table III which has been calculated from results of work by Mezger and Peyer who determined the vapour pressure of 2% ammonia solutions containing different proportions of CO_2 (*Gas and Wasserfach.* 68. 651). Virgin liquors obviously must be treated in some way with CO_2 before they can do useful work by absorbing ammonia in scrubbing plants. It was lack of appreciation of this point, which has been known for a long time now, that has led to some failures when cooled retort house liquor was substituted for water in final stage scrubbing.

I think now that this game is not worth the candle—except, maybe, in very exceptional circumstances.

TABLE III.

Ammonia in gas in equilibrium with 2% ammonia solutions containing different proportions of CO_2.

Ratio CO_2/NH_3	*Ammonia in gas gr./100 cu.ft.*	
2.6 $(NH_4)HCO_3$	77	*Mezger and Peyer*
2.4	84	
2.2	92	
2.0	101	
1.8	110	
1.6	120	
1.4	132	
1.3 $(NH_4)_2CO_3$	137	
1.0	310	
0.6	475	

N.B.—The last two figures were experimental results of the authors. Mezger and Peyer's curve did not rise so steeply.

Efficiency of Extraction

Taking as an example the case of a works with horizontal retorts, making 15 gal. per ton of virgin liquor and using seven gal. of water per ton of coal in the scrubbers, with a total ammonia yield of 6.8 lb. of ammonia per ton of coal, 25% of this being fixed ammonia, the strength of the finished liquor would be just over 3%, including 2.3% of free ammonia. This is equivalent to 10.6 oz. free ammonia. Can we not aim for something like this? It can be done. On one medium-sized works, using plant put in 50 years ago, it was possible to turn out 20 gal. of 16 oz. liquor per ton, the free ammonia content being 12 oz.

(*Continued on p. 468*)

ACCIDENT PREVENTION IN GASWORKS

Following is our report of the discussion on the paper on 'Accident Prevention in Gasworks' which Mr. F. A. Sanders, Works Superintendent, East Greenwich Works, South Eastern Gas Board, presented at a meeting of the Southern Association of Gas Engineers and Managers (Eastern District) on April 25 (Journal of last week, pp. 398-404).

The Chairman (Lieut.-Col. F. J. Gould) said the paper had caused him to refer to a book entitled 'Safety' which he had had for 30 years and which was published in America by William H. Tolman in 1913, at which time large industrialists, particularly in America, were beginning to get seriously interested in accident prevention. Tolman was the Director of the American Museum of Safety, and in the introduction to his book he claimed that it was the only comprehensive work on safety that had then appeared in the English language. The Chairman said he had made a few comparisons between some of the statements in this book and those in the present paper, having in mind that nearly 40 years had intervened since the book was written.

Tolman claimed that 50% of industrial accidents were preventable. Mr. Sanders, in his footnote to Table 3, claimed that this applied to 80% of the accidents at East Greenwich, which were listed. Tolman quoted accident statistics of the North German Iron and Steel Trade Association and these showed that accidents due to falls of persons account for 27% of the total. Mr. Sanders' figures showed approximately 22%. Tolman found that accidents mainly occurred in the winter months but that they mostly occurred after 4 p.m., and he attributed this to artificial lighting conditions. This was interesting, having regard to Mr. Sanders' remark that he had found that the black-out did not aggravate the liability for certain accidents to occur. It was probable, however, that the accidents to which Tolman referred were in factories.

Continuing, the Chairman said that Mr. Sanders' remarks about the decline in the number of accidents just before Christmas were most interesting, and it would be interesting to hear his explanation of this. Was it due to the extra care of the workman in his desire to ensure that he was not prevented from enjoying the festive season? Further, could the author say whether it was his experience that accidents were more likely to occur at the beginning of the week and at the beginning and end of the day, than at other times?

The remarks in the paper as to the accident proneness of new labour, particularly young ex-Service men, had a special interest for him. In a war, as was well known, men were taught to take risks lightly as in battle training, assault courses, &c. Would the author consider that, as a consequence, the ex-Service men showed more than the normal spirit of bravado generally common to young men, or would he ascribe the accidents sustained largely to inexperience?

Accent on Prevention

He agreed with the author's remarks about general posters and supported very strongly his views that emphasis should be placed on accident prevention and not safety first. In regard to the author's observations on the design of new plant, he found that Tolman in his book referred to stipulations made by American purchasing agents regarding provisions in machinery for safeguarding workmen and that clauses were inserted in contracts and orders designed specifically to secure adequate protective provisions.

Mr. **L. le Couteur** (Deputy Chief Inspector of Factories) said the paper was specially useful because it dealt with the non-machinery type of accident. For many years now, of the total accidents reported to the Factory Department, some 84 to 85% were due to causes other than the use of machinery and mechanical power, and the two causes, handling goods and falls of persons, had been responsible together for approximately 40% of the total number of accidents reported. In view of these high figures, these causes did not always receive the attention which their accident incidence merited. Perhaps one reason was that such accidents were seldom as spectacular as machinery accidents often were. A hernia caused by lifting did not cause the same interest and concern as did an accident in which a man lost an arm in a machine, but a hernia, although it might not be so patently obvious, was often a serious and permanent disablement. Again, measures necessary to prevent many of these non-machinery accidents were seldom as obvious as those in respect of dangerous machinery. When cuts were occasioned when handling sharp edged articles, even when such injuries were fairly frequent, or when a man fell because his ladder slipped, there was not the same enthusiasm in the search for safeguards as there was to devise a guard to prevent a machinery accident. The prevention of these types of accident required constant vigilance on the part of the responsible management not only as regards lay-out and good management, but also in the supervision of the methods of working and in the training and education of the worker. Those responsible for safety precautions had to be always on the lookout for new risks and the resurrection of old ones, and safety instruction had to be repeated again and again until the habit of safe working was formed, for it was only when the habit had been acquired that the training had been successful. This need for constant vigilance and constant consideration of possible risks and how they might be prevented was, of course, very fatiguing. Accident prevention officers were human and it might be that even they sometimes found difficulty in maintaining the degree of enthusiasm necessary if any substantial reduction in these classes of accident was to be attained.

Mr. Sanders in Table 3 gave some figures of the percentage of accidents under four causes, and it might be interesting to give the corresponding percentages for the whole of the country for 1948, covering the 861 fatal accidents and 200,225 non-fatal accidents, a total of 201,086. They were as follows: Falls of persons, 12.5%; stepping on or striking objects, 7%; objects falling, 9.4%; and handling goods, 29.4%.

Frequency Rates at Gasworks

In Table 1 the author gave frequency rates for the works at which he carried out his investigations, and there were figures in the Chief Inspector's Report for 1948, which might be of interest in this connection. In 1947, of 12 gasworks employing about 6,900, the mass frequency rate was 3.14, and in 1948, in respect of 15 gasworks employed 10,800, the mass frequency rate was 2.27. At the same time, the comparison of these works with the whole of the industry was a little dangerous and comparison with all industries was really not reliable. A snag was that if the figures of one's own works were good in comparison, there was the risk of becoming complacent, and while the efficiency rate figures in one's own works from year to year were extremely useful, his advice was not to bother about other peoples' unless they were better.

Again, figures of fatal accidents could be misleading and it would be interesting to know whether the author's figures were weighted, because in a small works one fatal accident might throw the figures out of all proportion to the real figures and what was going on in the works.

In regard to handling accidents, it would appear taking industry throughout the country, that accidents to young persons, particularly boys, were high and that men over 60 suffered proportionately to a greater extent than others. So far as younger workers were concerned, this seemed to be borne out by Fig. 1 in the paper, but at the other end of the scale it would seem that at these works steps were taken to reduce the risk to older people, although some rise was shown between the ages of 51 and 56. In regard to younger people, an interesting distinction had been reported by a medical observer that if given too much mental work a girl would break down while a boy would leave the work undone. The exact reverse appeared to be the case when the work was physical. Again, older men were very vulnerable to strain yet, as labourers, they were often given the more strenuous jobs which no one else would do.

The author's finding that strains formed a large proportion of the injuries in handling was borne out for industry as a whole. Non-slipping floors and non-slipping mats were very useful to prevent accidents when lifting.

In regard to safety boots, it would be interesting to know if the demand had been found to be falling-off in the gas industry. During the war the cost was not so very much but there was now the suggestion that the men were loth to spend money on what was not very attractive looking footwear

although they would spend it on something more attractive. He did not know whether there was anything in that.

In regard to the risk of epitheliomatous ulceration from pitch warts, he could not emphasise too strongly the need for voluntary examination every six months or so, so that pitch warts could be treated and excised before they became malignant. There would then be no further development of the wart. Otherwise, all the doctor could do was to give the man some alleviation of the pain which the later stages of cancer invariably produced.

Another matter was poisoning from CO when opening purifier drains. He would suggest an alteration of the arrangements so that the man did not have to go down into the tanks. The author had suggested breathing apparatus. Gassing did not appear in Table 2 and owing to the good reputation of the old South Metropolitan Company probably there were no gassing accidents at its works during the period under review, but the position generally in gasworks was nothing like as good as this. The purging of holders was common but the purging of purifiers was rare. Nevertheless, where practised, experience showed that pockets of gas were swept out.

Trained Personnel

Finally, emphasising that constant supervision, training, and education throughout the works must be placed on a proper basis, he said that every management should ensure that a sound safety programme was established and functioning effectively and efficiently at all times. In the larger works this would entail the appointment of trained personnel to advise on safety work at all levels and the establishment of democratically elected committees to discuss and consider safety in all its aspects.

Dr. **J. Meikelberg** (Chairman, South Eastern Industrial Group and Chief Medical Officer to Peak Frean & Co., Ltd.) was pleased the author had started off by stating clearly the reasons for accident prevention. Too many people looked upon accident prevention as an unnecessary evil and expenditure which need not be incurred, but personally he did not subscribe to such ideas. He was not personally concerned with the gas industry but with a firm which used a lot of gas and were therefore indirectly concerned with the prevention of accidents in the gas industry. Gasworks would not appear to be very different from other industries in regard to the accident rate from various causes. That morning he received the quarterly figures for accidents in his works. There were six lost time accidents during the quarter with a frequency rate of 0.6, but the most interesting fact was that every one of these six lost time accidents was due to persons falling. There was no machinery accident or any other type of accident except those due to persons falling, and some of them were due to the hurry of the person to get home from work.

Mr. **A. G. Palmer** (Works Regulations Officer, North Thames Gas Board) remarked that the author had dealt with the average severity rate, but there were many people who were coming to the conclusion that this did not achieve what it set out to do. He himself had particularly come to that conclusion now that it showed very little consistency. What he was now more particularly interested in was how much time was lost, on the average, per accident. For some years, in his own case, it had shown a persistent fall. In 1948 it took an upward turn but for the three years from 1947 the total number of accidents had fallen steadily and the hours lost in the same period had come down. He would leave them to draw their own conclusion from that.

Gas Light Comparison

He felt it was extremely dangerous to compare the results of one works with another because there were so many variable factors. In the case of the North Thames Board there had been found—even among the biggest works—considerable variations from one day to another and even from one class of plant to another.

Comparing some of the author's rates with some of his own—and taking roughly the same number of man-years as given—he said there was a certain amount of agreement. For 12 gas-making works of the Gas Light District, the process-carbonising accidents accounted for 36% against the author's 42%. Process (other than carbonising) accidents accounted for 17%, which was in close agreement, and, as regards maintenance, his figure was 47% against the author's 41%. These results might be affected by the degree of mechanisation between the works and there might be other factors.

As regards Table 2, there was a striking disagreement in certain respects and the biggest concerned the handling of objects. Mr. Sanders' figure was 23.9% while his own was 12.2% Some of the figures agreed fairly well but he found that the accidents due to fires and hot tar accounted for something like 25% of the carbonising accidents. But again, this might be affected by plant differences. A number of the plants were vertical plants in which falling charges were a hazard which was not present to the same extent in horizontal plants.

Turning to Table 3, he said there were again differences. Taking the over-all figures under the heading of 'carbonising' he had only 47% against 77% by the author. In the 'other than carbonising' category his figure was 58% against the author's 87.4%, and in maintenance his figure was 69% against the author's 82%. But these figures were very difficult to interpret because numbers affected the position far more than percentages. If there were three accidents out of 300 people in his own case and two accidents out of 200 in Mr. Sanders' case, the percentage would be the same, but if Mr. Sanders had two out of 800 his percentage would be considerably lower, and he wondered whether the percentages in the paper were affected by the fact that there were more of these common accidents happening in the author's works than in his own.

In regard to the figure of 158 lost time accidents in 1946, the frequency rate was something of the order of 5 whereas in his own case it was 3.5. In the case of machinery accidents there was a slight rise in his figure compared with the author's—nearly 5% compared with 4.2%—but there might be special reasons for the differences in both these cases. He had produced many charts of the type in the paper but he felt they had not got him anywhere. It seemed to him that the reasons given in Fig. 1 might be overshadowed by the experience factor. In his case this figure was 28%. In other words, a larger number of accidents had occurred within the first 12 months of employment and in most cases that would cover the range between 16 and 40 years of age.

Accident Proneness

Accident proneness was one of the things he would like to argue but perhaps he had better not, because he heartily disagreed with the author on that question. He did not like to apply 'accident proneness' to a man through causes which he had not been told of or made aware of. His own view was that accident proneness was due to placing square pegs in round holes.

The comments with regard to reduction of accidents just before Christmas were perfectly true; he had found exactly the same. Indeed, he would go farther and say that hardly ever did a man have an accident within a fortnight of going for his summer holiday. Of course, as regards fewer accidents just before Christmas, a good deal depended on the amount of work done during that period.

There was a great deal to be said for the appointment of accident prevention officers and there had been cases in which full-time officers at a works had produced considerable benefit. In others, it had been found satisfactory for these officers to share their duties between different works.

One of the biggest factors in gasworks in particular was design. He was recently privileged to see a survey made by a very large undertaking which had gone into accident causation very carefully and their assessment of the accidents caused by faulty design of trucks was 30%.

Dr. **R. E. W. Fisher** (Chief Medical Officer, Metropolitan Division, South Eastern Gas Board) said the author had mentioned strains but it was difficult to tell the difference between strains and lumbago, and a diagnosis very often had to be made not on the man's symptoms but on his honesty. However modern medical science was showing more and more conclusively that what had been for many years considered to be a lumbago and rheumatic condition was, in the majority of cases, the sequel to an accident perhaps years before. It was now becoming a fashionable complaint known as the 'slipped disc' of which no doubt many of them had heard. Why that condition should be more common in the winter he did not know, but there was no doubt it was more common in the winter and it was possibly due to the fact that there was a constitutional factor involved, that the condition of the muscles was not as good in the winter as in the summer. That was pure

speculation on his part, but of the effect there was no doubt.

Commenting on the reduction of accidents just before Christmas and the annual holidays, he said there was no doubt that one reason, as the author had suggested, was that the man wanted his pay packet. In the absence of other evidence he would continue to believe that there was another factor; that a man who was doing well and was cheerful and happy was a man less liable to have accidents than a man who was bored and dis-spirited. If the number of accidents in the country as a whole was plotted against cheerful news and bad news, it would be found that bad news tended to increase accidents. He was quite certain of that. If the number of accidents after the last Budget day was plotted, he was quite certain it would be found they went up. Much the same was seen during the war. There was an important point there, and it was a well known fact in the Services that a happy unit was an efficient unit and one free from unnecessary accidents.

A point on which he wished to join issue with the author was his contention that the majority of accidents were avoidable by the employees themselves. After all, it was possible to avoid accidents by staying at home. In this connection, they would be well advised to remember the maxim laid down by the late Sir Thomas Legge on industrial disease, rather than industrial accidents. He said that until the employer had done everything or nearly everything, there was little or nothing that the employee could do for himself—and Sir Thomas Legge was a very wise man. Personally, he thought he was right on that point.

Industrial Diseases

As regards pneumoconiosis, he did not want to say much about that. It was a matter that had recently become a serious problem in the gas industry and it was very probable that there was a lot in it in the gas industry that had not been discovered and it was, to all intents and purposes, unsuspected. Unless the personnel were under the medical supervision of someone who was keenly alive to the possibility of this condition arising, the chances were that it would not be diagnosed at all and a man could go to his grave said to be suffering from chronic bronchitis when it was pneumoconiosis. That had happened for many years in the coal industry. The discovered instances had increased very considerably although the general position had improved in the coal industry.

It was probable that the introduction of high silica refractories in fairly recent times had caused an increase in the cases of pneumoconiosis, and the number had increased recently, yet he was certain that only a fraction of it had yet been discovered. Fortunately, there were one or two factors which could cause a certain amount of satisfaction. One was that it was only in limited circumstances that a man would be working on these refractories year in and year out. Most men only worked on them during the summer and in small works they did not necessarily work on them every season. Thus their exposure was interrupted and the incidence of the disease was not as serious as it would be. But the complaint could arise quickly and he was sure there was a good deal that was still undiscovered. What the answer would be he did not know although the answer must lie in the hands of the engineer. The doctors could only put it up to the engineer and say what was happening, and leave him to find the answer. The various methods of preventing it were well known and it was only the question of deciding which of them was the best.

As regards pitch warts, the danger here was in concealment. Once they were disclosed to someone familiar with the conditions they were easily treated and they were best treated by X-rays which were not painful to the patient. Most patients did not like having them excised. Fortunately, the cancer which arose from pitch warts was exceptional in that until a relatively late stage it was easily treatable and curable and in the vast majority of cases could be cured. Pitch and tar cancer caused a measurable number of deaths throughout the country. He believed the figure was 7 or 8% but he understood that in London there were very few cases because the supervision in London was very good. In his own case he believed there had been only two deaths in the last 25 years. One of these was due to deliberate concealment and the other case was one that nobody could guard against because the man point blank refused to have any treatment.

Mr. **Cracknell** (Safety Officer, Sydenham Works) referring to accidents in the case of drafted labour, asked if the author had found many of these were due to strained backs. He had found that many men from the Forces had developed strained backs because they did not like the job! Had the author the same experience? As regards the silica contents of the refractories, were those used by the author cut by machinery or were they treated by hand? As to the safety boot, it was the fact that these boots were not as well fitting as they might be, and now that the general situation was improved men were driven to other boots because they were easier. He believed the manufacturers were making half-sizes to put this right.

Lighting Installations

Mr. **C. A. Deas** expressed surprise that the author had not laid more emphasis on the question of lighting, particularly at night time. The average works was very poorly lighted at night. Moreover, it was not sufficient to put in a good lighting installation unless there were also efficient means for maintenance. He had seen cases in which one mantle was alight and three had been blown off, and also cases in which the electric lamp bulb was dirty and little light could get through. There was also the question of a failure of electric power where electric lighting was used. He had seen power houses in complete darkness. There should be an alternative means of lighting where electricity was used. No mention had been made by the author of the use of flume conveyors in the retort house, and it would be interesting to know the effect of these on the accident rate. Further, no mention had been made of open floors. They were very nice, perhaps, but they were very dangerous, for tools could slip through and hit somebody down below. There was also the need for guards when men were working up above, and nothing had been said about that.

Mr. **Roy Summerson** (Luton), referring to the statement in the paper that 'to a degree the management must accept the responsibility for seeing that stages, walk-ways, &c., are kept clear,' said that in his experience the authorities took the view that the management must accept not a degree of responsibility but all the responsibility. In many cases where a man had suffered an accident through falling over something on the floor, the management had been 'on the mat' for not seeing the floor was kept clear. It was up to the management to see that the men did their duty as regards sweeping up and so on. In a similar manner, if an employee removed a guard from a machine and an accident occurred, the management got into hot water for failing to see that the guard was kept in position.

In regard to accident proneness, he had experience a few years ago of a fitter who had so many accidents that it was said among the staff that if he were given a rubber hammer he would hurt himself! As a result of this experience he had concluded there was such a thing as accident proneness.

The Author's Reply

Mr. **Sanders,** replying to the discussion, said he did not think there were any reliable statistics which showed whether accidents were more liable to happen at the beginning or end of the day or week. As regards ex-Service men, there was a certain bravado about them and many accidents were due to this. Commenting on the interesting quotations by the Chairman from the book by Tolman, he said that many present were old enough to remember the old gas engines and steam engines with open cranks and no guards. Now these were totally enclosed jobs and he asked why that could not be applied to all machines and incorporated in the original design instead of being added afterwards.

His severity rates were weighted and he thought he had made that clear in referring to a fatality which would put up the rate.

As regards safety boots, among the 1,800 employees at his works some 300 pairs of these safety boots were sold in a year. On the question of poisoning from CO when opening purifier drains, he agreed with the suggestion of an automatic chute but so many purifiers were designed 40 years ago and the drain cock was in an inaccessible position. The man had to go down and open the cock, and when that was the case he should not go down alone and breathing apparatus should be worn. He agreed with Mr. Palmer as to the limitation of using frequency figures as a basis of comparison. With regard to Fig. 1, Mr. Palmer had suggested that this was not as useful as it might be because it did not bear any relation to the actual number of people, but these figures were of accidents per 100 man-years.

In regard to accident proneness, this was a debatable point and certain people disagreed about it. He had expressed his

own personal views in the paper and was a believer in accident proneness. In connection with the relationship between the amount of work done in Christmas week and the number of accidents, actually they were busier at Christmas time than at any other period, so that there was no reduction in the amount of work done.

The remarks by Dr. Fisher in regard to lumbago were extremely interesting. His own records were started in 1942 and there was a marked improvement immediately after the war. The reference to the late Sir Thomas Legge was in connection with industrial diseases, but this paper dealt with general accidents and he maintained that the majority of them were preventable by the employees. He knew that the management had to take the responsibility but the man who left the things in the gangway was the man who caused the accident.

Replying to Mr. Cracknell he said there had been strained backs in the case of drafted labour. As regards the handling of refractories, there was enough material for a paper on the subject. It had to be agreed that the trouble from pneumoconiosis had been developing in recent years. Thirty years ago the material was all hand treated.

Mr. **A. Tran** (General Manager, Northern Division, Southern Gas Board) proposing a vote of thanks to the author said he had been impressed by the statements in the paper that four out of five accidents in gasworks were preventable and that 40% of them were due to falling. This was really a serious admission, but fortunately the situation could be cured by serious endeavour. The Gas Act laid it down that area boards must promote the safety, health, and welfare of employees, and no doubt the authors of the Act had in mind the high rate of accidents in gasworks. The paper provided the industry with a sound basis on which to conduct investigations in the future. The fairest way was to lay the blame equally on the employers and the employees. Then there would be a very much better chance of getting more assistance from employees in helping to reduce the number of accidents.

Mr. **J. H. Hornby** (Manager, Hastings) seconding, said this problem resolved itself into one of the human factor. The gas industry had had to take all kinds of labour and no doubt a good many accidents could be avoided if the employees gave a little more thought to their job instead of possibly thinking of other things.

OPERATION EFFLUENT — continued on p. 464.

We must drive for efficiency of ammonia recovery in the future and discontinue some of the questionable practices of the past if we are to fulfil all our obligations under the new Acts of Parliament. By the way, to recover ammonia and make it available as a fertiliser—which is needed—is going to cost us something. We must, therefore, guard against all possibilities of wasting it by losing it in the atmosphere. It might be pointed out that some of our experiments have shown that exposed surfaces of liquor lose ammonia at quite a high rate. Do keep the covers on wells and seal pots, particularly where hot liquor is involved.

Something I want to hammer home once more is 'any oxygen, however little, in the gas up to the inlet of purifiers is too much!' Do stop all leaks in the retort house, and do not have any plugs which can be taken out, or cocks which can be opened, to admit air on the vacuum side of the exhausters. Proper arrangements should be made at once, wherever air for purification is not put into the gas at the purifiers under pressure, to do that. It will pay, and at the same time consideration should be given to its admission to the second box if the purifiers are of reasonable size.

I am afraid that in too many gasworks the ammonia extraction plant has not been kept up to scratch 'because we lose money on ammonia anyway.' In how many works is a proper test made regularly for ammonia at inlet to purifiers? I have a feeling that some of us would be shocked if we knew. Oxide purifiers are provided to remove H_2S. They will remove a lot of ammonia also if there is plenty of oxygen present to help the process on, but the final results of this are not good because:—

(a) Ammonium salts in spent oxide are objectionable.

(b) The performance of the oxide in the purifiers is not as good as it might be.

(c) A shocking effluent is produced in appreciable quantities.

(d) The crude liquor is weaker than it would be if the extraction were efficient, and so it is less attractive from the point of view of concentration.

(e) Oxide purifiers are not 100% efficient as ammonia extractors, and almost certainly some ammonia will be present in holder water and in the gas passing to the district. Very little ammonia in the wrong place can cause a lot of trouble and the reason for the difficulties may not be suspected.

On any gasworks all the drainage from oxide purifiers should be put into the crude liquor well.

PART IV

Another toxic effluent I want to mention is that from water gas plants. Water gas effluents are in a similar category to petticoats in Victorian days—not talked about! If a lot of fresh water is run into the wash-box and away to the drain, it will be weak certainly, but quantity may have to be paid for. It may contain a little tar oil, which should be separated from it before it goes into the sewer. If the gas is carburetted it will contain some oil which is not easy to remove, and in the cases where a C.W.G effluent has to be disposed of there should be a re-circulation system in operation, so that the only effluent is that due to undecomposed steam from the plant. In the matter of the oil content of trade effluents, some local authorities are becoming more particular, and quite low limits are specified. In the late Watford and St. Albans Gas Company we gave this subject some special attention, and now all the works in the Watford group have a small plant designed on the lines shown in Patent No. 618,516. A fairly complete description of it is given, together with some test results, in the specification.

Effluent liquor from a carburetted water gas plant contains appreciable proportions of ammonia, tar acids, and thiocyanate, so it requires care in disposing of it just like ammoniacal liquor or spent liquor.

All waste waters on the works should, preferably, be brought together into one effluent tank in which solids can be settled, and oil separated, before the cleaned liquid is allowed to flow into the sewer.

Whatever else happens, see that objection cannot be raised against your effluent because of high temperature. It should not exceed 110°F. There are many points in the 1937 (Drainage of Trade Premises) Act which are arguable, but that point is easy and quite straightforward for an inspector with a witness, if he has some reason to be dissatisfied. 110°F. is not very hot.

Since vesting date, area boards generally have taken some action to deal with the problems arising out of effluents disposal in their own areas.

As was announced recently, a new committee has been set up by the Institution of Gas Engineers, to go into the practical aspects of the disposal of gasworks effluents, while an advisory panel of eminent chemists deals with the research side of the problem.

There is a lot to be done at this high level and it will take time, but there is no need for we people on the works to wait for further reports before we make a move.

Our job? It is simply this. To get the maximum yield of free ammonia into the smallest possible volume of liquor, and to see that no effluent of any kind contains oil or suspended matter.

Where there is a concentrated liquor plant, to see that it is efficient. Where there is not a distillation plant, to look into the possibilities, not forgetting Parrish's paper published by the Institution during the war on small concentrating plants. In my opinion that paper did not receive the attention it deserved. Lastly, shall we examine again the question of giving it away to farmers? I have used it on my lawns at home and it seems to work quite well. That may well prove to be the best answer to the problem in some places.

RESEARCH AND THE USE OF TOWN GAS*

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The purpose of this paper is to review the applications of scientific research at the present time to the problems which arise in attaining high efficiency in the utilisation of gaseous fuel. It is apparent that the acquisition of new knowledge regarding the fundamental mechanism of combustion under differing practical conditions must play an important part in this, and it is not surprising to find that considerable research effort is being applied in this part of the field also from a number of directions outside the gas industry. The results of such study will, in time, permit the more rapid solution of problems as they arise.

IN the use of gaseous fuel the objective is not thermal efficiency only, but may be chemical efficiency or, as in domestic heating, even physiological efficiency.

The problems in the use of town gas which are discussed in this paper are those to which the best solution will be found by the growth of scientific knowledge in the fields of combustion, heat transfer, and corrosion and also in the subject of human comfort in relation to its environmental conditions. Conditions can and do arise when the circumstances required to control combustion, to achieve the most efficient heat transfer, and to eliminate corrosion are mutually contradictory and the compromise which will give the most effective utilisation of the gas is influenced differently in different cases by the emphasis placed on each.

In the use of gas the following general pattern can be traced. The starting point is the flame—that is, the region in which the chemical reactions between gas and oxygen occur. To use a flame it must be controlled in size, form, and stability and since these properties of a flame depend on the physical processes therein and also since they occur in a gas stream, the problems involved must be regarded first from an aerodynamic viewpoint. The physical control of the flame is obtained by means of a burner, which can also have the important function of providing primary aeration. Associated with the burner there must be a combustion space and it is at the boundaries of this space that the useful heat transfer first occurs. These processes may be followed by corrosion.

Combustion

The flame is the region in which the reactions between combustible gases and oxygen occur, but the extent of this region tends to be misunderstood since part of the radiant energy emitted is in the visible part of the spectrum and the visible flame is often taken to be the whole. The reactions actually spread over a much larger zone. The flame region has no precise boundaries and it is consequently very difficult to define.

To make the best use of a flame it is necessary to understand the processes occurring in it. When these are considered, it is found that only since the idea of chain reactions became accepted in fairly recent years has any great advance in understanding been made. Even in the simplest case, the combustion of hydrogen, the mechanisms are complex and there is more than one chain mechanism possible.

From knowledge of the behaviour of active atoms and radicals, it is possible to construct the following reaction pattern for the combustion of hydrogen with oxygen:—

$OH+H_2$	=	H_2O+H	1
$H+O_2$	=	$OH+O$	2
$O+H_2$	=	$OH+H$	3
$H+O_2+M$	=	HO_2+M	4
HO_2	=	chain breaks	5
HO_2+H_2	=	H_2O_2+H	(i)6
HO_2+H_2	=	H_2O+OH	(ii)6

The radical M represents the third body in a third body collision. This means a collision in which two bodies collide and then a collision with a third body takes place within a short time. The duration of this time is fixed by the following considerations. Suppose the two bodies in the first collision can combine to form one particle which then has excess energy over its normal state and is likely to split up again. This excess energy may be removed by a collision with another body and the particle formed by the first collision will then be stable. If the second collision occurs within a time less than the average life of the particle with excess energy, then it is probable that de-energisation will occur and the particle will become stable.

It will be seen that starting from one OH radical in (1), chain branching occurs and in the three reactions 1, 2, and 3, one molecule of water is formed and two OH radicals plus one H atom. The H atom can react according to 4 and 5 or 6(i) or 6(ii). The OH radicals formed in this process become the starting points of similar chains and the rate of the reaction therefore accelerates and the explosive combustion ensues.

It is not possible to prove directly that this pattern does occur in the combustion of hydrogen and oxygen, but it can be shown that all the phenomena associated with this combustion process are adequately explained by this pattern.

The pattern was obtained by selecting the most likely reaction scheme from the various possible reactions. Examples of reactions that could reasonably occur, but which are now necessary for explaining the known phenomena are:—

HO_2+H_2	=	$H_2O_2+O_2$
HO_2+HO_2	=	H_2O+OH
H_2O_2+H	=	H_2O_2+H

The complexity of the possible reaction schemes for fuel gases more complicated than hydrogen can readily be imagined, and for a mixture such as town gas the reactions occurring become most involved. Consequently, although the gas mixtures used and the end products formed are known, there is still a great deal to be discovered about the intermediate stages of the reactions occurring during combustion.

Methods which have been employed to investigate these reactions are the determination of (i) flame velocities, (ii) limits of inflammability, (iii) the product of the reactions, (iv) radical formation by spectroscopic investigation, and (v) conditions for slow combustion.

From measurements of flame velocity of fuel gas/air or oxygen mixture, deductions concerning the processes occurring during combustion may be made. Data on the variation of flame velocity with temperature and with additions of small quantities of various substances to the mixtures being burnt are particularly useful. To give a simple example, if the addition of a material which is known to increase the concentration of one of the radicals known to be present in the combustion process produces a large increase in the flame velocity of the mixture, then clearly this radical plays an important part in determining the velocity.

From a study of limits of inflammability of mixtures of a fuel gas and air or oxygen and the effect on these limits of variation of such factors as pressure, temperature, nature of surface exposed to the gas, and addition of small quantities of impurities, deductions may be drawn about the rate con-

* Paper to the Midland Junior Gas Association, April 18, 1950.

trolling reactions concerned in the combustion of a particular mixture.

Spectroscopic investigation of flames enables radicals formed as intermediate products in the combustion reactions to be identified in the cases when the radicals emit radiation within the range of the spectroscope. Furthermore, by measurement of the relative intensities of the spectral lines it is possible to learn something about the distribution of energy among its various possible forms in the reaction zone of a flame where thermal equilibrium is not to be expected.

In a premixed flame at atmospheric pressure the explosive reaction zone is very thin and it is impossible to make a detailed study of this with a spectroscope. It has therefore been a common practice to use flames at very low pressures (down to 1 m.m. of mercury) and thus to obtain a flat flame and a very thick reaction zone which can be studied in detail. Egerton and Powling have recently developed a very promising method for obtaining a large flat, premixed gas flame at atmospheric pressure by having a uniform gas flow across the burner. The inner cone of the flame is normally very thin, but widens for very slow and rich flames. Recently, Wolfhard and Parker[3] have evolved a new technique for which a diffusion flame of a suitable form for detailed spectroscopic examination may be obtained at atmospheric pressures. A flat burner is used and the fuel gas and oxygen issue with equal velocities (of about 20 cm./sec.) from the two sides of the burner. The gases rise vertically and diffuse into each other in a laminar flame on account of the low Reynolds number. On ignition a flat diffusion flame is obtained which gives a reaction zone up to 1 cm. thick depending on the height of the flame. The flame front is kept steady by stabilising it with a surrounding stream of nitrogen which flows up the outer jacket.

Recently the intermediate stages of combustion reactions have been investigated by the mass spectrograph[4]. This is an instrument for measuring the ratio of the mass of a charged particle to its charge. If the atoms and radicals in a part of the flame region are withdrawn and ionised so that they are charged, their mass may be determined since the charge will be known in terms of the charge of an electron. The principle of the instrument is to deflect the stream of particles by first an electrostatic field and then a magnetic field. By this means, with suitable adjustment of the field strengths and spacing, a beam of particles with the same mass/charge ratio is brought to a focus, the locus of the foci is a straight line and a photographic record may be obtained showing the particles present. Although the mass spectrograph is more complicated than the optical spectroscope, it has the advantage that it is not subject to the limitation that only atoms and radicals with energy levels suitable for the absorption or emission of radiation in the working range of the instrument may be detected.

The study of slow combustion helps by providing a means whereby the course of the combustion reactions can be followed by chemical means. In this case the mixture can be put into a heated closed reaction chamber and the progress of the reaction observed either by noting the pressure change or by analysis of the reaction gas withdrawn after a certain time. Alternatively, experiments may be carried out with flowing gases, the mixture being led through a heated reaction tube and the escaping gases analysed. Information about the intermediate stages of slow combustion obtained by such means cannot be applied directly to the normal combustion processes owing to the different conditions in the two cases, but it can provide a very useful guide to the processes likely to occur in normal combustion.

The processes occuring in the flame are being unravelled by the methods just described. One of these processes is that by which the original concentration of atoms or radicals, which form the starting points of the chain reactions, are produced. This is the initiating reaction and it is the controlling factor in the ignition of the flame. Until this process is understood the problem of flame ignition cannot be fully understood and the attack on this problem must be handicapped.

From the practical viewpoint, interest in the course of the combustion reaction arises from the intention to use the energy released. The total of this can be measured, but for its efficient utilisation it is also necessary to know at what stages in the course of the reaction this energy is released and also in what form it then appears.

When a radical is formed as the result of an exothermic reaction the energy released in the reaction appears as either external or internal energy of the radical or possibly as both. The external energy takes the form of increased translational energy of the particle and the internal energy may be in the form of increased vibrational energy of the atoms forming the molecule or of increased rotational energy of the molecule, or of increased electronic energy. If this particle takes part in no further reaction, its energy will tend to be reduced to the level corresponding to the temperature of the gas stream in which the reactions are proceeding. The reduction of energy can take place either by emission of radiation or by sharing of energy on collision with other particles. It is possible that the activated radical will persist long enough for the deactivating collision to take place on a surface which is being heated by the flame. In that case the energy released is applied directly to the heat transfer process. Knowledge about the energy release during combustion processes is obtained by the same methods as are used to investigate the course of these.

The Physics of Combustion

Since the flame is a region in a stream of gas in which the combustion reactions are occurring, it follows that adequate control of the region is essential. Such control is the main function of the burner.

If the flame is to be used effectively, the factors which control its form and structure and which determine its stability and flexibility must be understood. These are largely physical and are best investigated by aerodynamic methods. A great deal has been learnt about the control of flames by empirical methods, but aerodynamics methods of investigation have only been widely applied in recent years. There are now a number of workers in this field.

Critical reviews of work on aerated burners during recent years have been given recently by Garside and Culshaw[5] and by Minchin[6]. These present the work of Lewis and von Elbe in the U.S.A., Damkohler in Germany, Delbourg in France, and Adam in Holland among others. In addition, there is the work of Garside and Culshaw at Leeds[7]. Similar work is also being carried out for diffusion flames by Garside and Scholefield[8]; and this is being continued, using shadow photography at Leeds and the Schlieren technique at Beckenham. Some studies of diffusion flames by the Schlieren technique have also been reported by Wolfard and Parker at the Royal Aircraft Establishment[9]. A different technique is being used to investigate the aerodynamics of gas streams by Radiation Ltd. The method is to take a pitot tube traverse of the stream so that a knowledge of the stream velocity and density may be obtained across its section. In order to experiment with small streams such as occur in burners a micro-pitot technique is necessary.

Flat flames and turbulent flames have been investigated much less intensively by aerodynamic methods designed to explain their stability and structure. Since the use of both types of flame is increasing, it is very important that the fundamentals of their behaviour should be understood. Minchin has recently put forward an explanation of the structure of flat flames, which awaits experimental verification[10]. Experimental investigations of the effect of turbulence on flame velocity have been made by G. Damkohler[11] who obtained an approximate expression for the velocity of flame propagation in small scale turbulent flow. Similar work has been carried out by W. Heiligenstaed and by P. Delbourg. Investigations of this kind for flows with other scales and degrees of turbulence are particularly needed since turbulent flames are of growing importance in the industrial field.

The flexibility of the flame is an important factor in determining the tolerance of an appliance to different conditions

of use—that is, the range of gas input and quality over which satisfactory stability and performance are obtained. This flexibility is the subject of two complementary investigations by the Gas Research Board. One of these, using mainly the combustion diagrams in the form due to Fuidge[12], consists of an investigation of the effects of composition of the gas on its combustion characteristics, and the other is an investigation of the tolerance of existing appliances to change in gas quality.

The development of a method of determining the combustion characteristics of a gas is of great importance to the industry. As yet it is only possible to make various assessments by methods adjusted to suit particular conditions. Useful information has been obtained for aerated flames, but much less is known about diffusion flames. In any case, the work so far is largely empirical and has no complete theoretical background. If it were possible to predict from fundamental data the behaviour of the flame formed by burning gas mixtures of the type of town gas, under given conditions, the problems of appliance design would be considerably reduced and much better evidence would be available on which to decide the degree to which it is desirable to control gas quality. A review of methods of assessing combustion characteristics has recently been given by Minchin in a paper read to the Southern Association of Gas Engineers and Managers. In this are discussed the combined combustion and aeration diagrams, the Chaso curves due to Wood (*i.e.*, cone height versus air shutter opening of the Aeration Test Burner) and various test burners—the Ott, the A.T.B., the Rochester Test Burner and the Czako-Schaak.

Another important factor influencing the physical behaviour of flames is aeration. This has been studied extensively and a considerable amount of empirical information has been collected. Recently useful contributions to our fundamental knowledge of primary aeration have been made by Silver[14], when he was with the Gas Research Board, and by von Elbe and Grumer[15] in America. These theories are approximate and ignore various secondary factors influencing primary aeration, but from them, given the physical dimensions and constants of the burner and gas, it is possible to calculate the primary aeration of a burner with reasonable accuracy.

It was pointed out by Minchin that both the American and British work indicated that the air/gas ratio decreased continuously as the thermal input to the burner was decreased, while he had experimental evidence that this ratio for town gas begins to increase at very low inputs. I have since verified this experimentally and also shown that this phenomenon occurs with all simple gases investigated to date. The factors responsible for this are now being sought. It is obvious that this effect may have an important bearing on the behaviour of appliances as the gas is turned down.

Little progress has been made in our understanding of secondary aeration and data concerning this appear to be very scanty. Accordingly, measurements of the flow of secondary air into a flame are now being made at Beckenham. Two methods have been developed. The first uses the quartz fibre anemometer to measure the component air velocities in two directions at right angles. To use this it is necessary that there shall be no air flow in the direction normal to the plane defined by these two directions, which means that a flame must be used which has uniform characteristics over a width large compared with the dimensions of the anemometer. This condition in effect restricts the use of the method to the laboratory. The second method is an application of the technique for tracing streamlines and making velocity measurements in fluid motion by introducing particles of powder into the fluid stream. This was first used by Andrade for investigations into liquid flow and was subsequently used in several applications with suitable modifications and was recently extended by Lewis and Von Elbe to flames in their work on flame stability referred to above. We have further adapted the technique so that it may be applied to show air movements outside a stream of gas. This method is not subject to the restriction that limits the use of the quartz fibre anemometer and can be applied to most flames and appliances. It has, in fact, already been used to investigate the movement of the layer of air immediately in front of a gas fire, in order to determine what part of this passes up the flue and what part circulates round the room by convection. The advantage of this method over the usual smoke methods is that measurements of air velocity are obtained instead of only the direction of motion.

The use of injectorless gas burners is now increasing and this, of course, increases the importance of fully understanding secondary aeration and the diffusion flame.

It is appropriate to mention here the subject of noise in burners, since one of the reasons for the use of injectorless burners in domestic appliances is the absence of noise compared with an aerated burner. Noise can be troublesome in the domestic field, but is much more serious in the industrial field and does, in fact, limit the application of concentrated combustion burners in certain directions. The cause of noise has been the subject of a preliminary investigation by the National Physical Laboratory[16]; this work will be continued when possible.

The Combustion Space

Associated with the burner in any appliance there must be a combustion space at the boundaries of which the useful heat transfer normally occurs.

The basic problems arising in connection with the combustion space are those of ensuring that complete combustion is obtained and that the gas flow pattern gives the required heat transfer. The latter is another problem of aerodynamics, to which insufficient attention has been paid. There is very little known, for example, about the flow inside furnaces. Recently, Chesters, Howes, Halliday, Phillip, and Newby[17] have published a series of papers which give some extremely interesting flow pictures for open-hearth furnace models. Some surprising results were obtained particularly on the masking effect of the stream of products from one flame on a second flame or two and three flame furnaces. It is clear that similar studies of gas operated appliances could be made with advantage.

One of the major difficulties in designing the combustion space is to arrange for the satisfactory removal of the products of combustion. The nature of this problem varies. In the domestic field, for example, there are alternative methods of disposal—there may be a flue available, or, if not, it may be possible to insert a balanced flue or again a flueless appliance may be used. The third possibility depends on the space available, the ventilation, and the consequent vitiation produced in the atmosphere. An acceptable limit for this may be determined from physiological data. One of the difficulties about vitiation is the effect of this on carbon monoxide production. There is a tendency for the CO/CO_2 ratio to increase as the proportion of CO_2 in the air increases, but the effect varies considerably for various burners. This subject is being investigated by Radiation Ltd., Watson House, and others. Recently, some results of combustion in vitiated atmospheres have been published by Mullins and Barr of the National Gas Turbine Establishment[18].

Acceptable standards of ventilation are hard to determine. Information on these is being obtained from such work as that of the Building Research Station, Dr. Anderson of the School of Hygiene, and the large scale experiments by Radiation Ltd., at Stanmore, on two complete houses. Here the ventilation is being determined from the variation of the CO_2 content of the air inside the house. The first indications from this work are that there is a correlation between the ventilation and the wind velocity. Ventilation is also being studied from the aerodynamic viewpoint at Watson House.

Another important difficulty in designing the combustion space is that of obtaining refractory materials of suitable quality at an economic price. This difficulty is particularly severe on the industrial side where the development of furnaces for use at higher temperatures is often limited by the availability of suitable refractories.

The design of the combustion space may be complicated by the effect of the inner surface of this space on the com-

bustion process. The surface can act in two ways, either by catalysis in the classical manner or by initiation or breaking of reaction chains in the gas phase. An example of the effect of surface on the combustion process is incandescent surface combustion.

The design of the combustion space and of the type of burner associated with it depends largely on the rate of heat release required. In certain industrial processes, for example, an intense local heating is desired, and for this a burner giving a very high rate of heat release per unit volume is needed. As is well known the concentrated combustion or tunnel burner has provided an admirable solution to this requirement. But why the rate of heat release per unit volume varies with the different types of flame is not fully understood. This rate is higher in an aerated flame than in a diffusion flame of normal shape; it is greater still in flames of the types obtained with tunnel burners and the upper limit of this rate is that obtained in detonation. An increased rate of heat release per unit volume is obtained by accelerating the combustion process. Clearly the method of mixing air and combustible gas will influence this rate, as also will the flow state in the mixture as it approaches the combustion region. Both from theoretical considerations and from practical experience, it is clear that conditions of turbulent flow increase the speed of combustion. Apart from the effects of such factors as mixing and flow state, the reasons why the rate of combustion varies in these different types of flame is only known very broadly, and there is little knowledge about the difference in the combustion process. It is important to understand the factors controlling the rate of the combustion process in order to determine the scope for still further acceleration. This problem is now being tackled by the Gas Research Board. At Leeds an attempt is being made to obtain a controllable detonation type of combustion, while at Beckenham the mechanism of and type of combustion in a concentrated combustion burner is being investigated.

Heat Transfer

The use of gas involves two main processes, first the production of heat by combustion and secondly the application of this heat. The heat transfer may occur by convection or by radiation and, for any particular application, either one of these processes alone or both together, may be required.

For example, in lighting, ideally all of the energy produced by combustion should be distributed as radiation, for convectors all of this energy should be transferred by convection, and for gas fires some heat transfer by both methods may be desirable. By suitable control of the flame and by interposition of secondary substances, such as refractories, between the original source of heat and the final object to be heated, the division of energy between the two heat transfer processes can be varied.

The problem of heat transfer is complicated since the transfer is taking place from a gas stream which is not under equilibrium conditions. There is a departure from equilibrium both in the energy states of the individual stream particles and in the flow state of the stream. The stream particles are not in energy equilibrium since, in general, heat transfer in gas appliances takes place from the gas in the reaction region where energy is being progressively released and where the molecular species may have abnormal energies in the various degrees of freedom, and may be activated. The late Professor David often stressed the importance of the latent energy of these activated particles. An attempt to estimate the importance of this last factor is being made by the Gas Research Board team at Leeds[20] and it has already been shown that the contribution to the heat transfer by activated particles may be considerable. The flow state of the stream is not in equilibrium, since, in general, the useful heat transfer from the stream takes place in a short length of path close to the point of entry of the stream to the heat transfer passage. Consequently, the boundary layer is still being built up to its full thickness and the flow is still affected by the entry conditions so that it is difficult to calculate the heat transfer. A study of these entry conditions for the various geometrical shapes in practical use would be of great assistance.

A lack of equilibrium in the energy states of the particles in a gas stream which is burning is the basis of the difficulty in measuring the temperature of the stream.

Temperature is a measure of the average molecular kinetic energy with the assumption that equilibrium exists and that there is an equipartition of energy between the various states of motion. It is clear that, strictly, a temperature cannot be assigned to a stream of gases such as is under consideration. Yet, since heat transfer coefficients are defined in terms of a temperature difference, some suitable compromise must be made in order to make use of the information and methods available.

Convection

There is a large amount of data about convective heat transfer, and thanks to the efforts of Saunders and Fishenden and others[21], this is often in a form that is readily applicable. Naturally, this data has mainly been obtained with the general conditions of the chemical engineer in mind and consequently there are gaps in the kind of information that is required to treat the convective heat transfer problems that arise in the use of town gas. For instance, data is required on transfer coefficients at very high and very low flow rates, at very high temperatures and for shape effects, such as the curvature of the leading edges of fins. A discussion of certain aspects of convected heat transfer has been given by Bennett[22], together with some experimental observations on heated vertical tubes. This work is a good example of the type of information that is required. Some interesting information has recently been published by Cohen and Jessel (Nash & Thompson, Ltd.)[23] for heat transfer in water heaters. A transverse finned tube type of heat exchanger was considered and the effects of radiant and convective heat transfer determined. The effect of structural modification was also considered. This paper is also interesting as an illustration of the interconnection between combustion, heat transfer and corrosion.

It is intended to start work on convective heat transfer at Beckenham as soon as possible and it would be interesting to hear the views of this meeting on the relative importance of various factors such as those mentioned above.

Radiation

The measurement of radiation from appliances has received attention from the industry for many years. Briefly recapitulating, the Leeds method for standardising the measurement of such radiation was introduced in the early years of the century. Shortcomings were revealed in this and modifications were made by various workers in two main directions—first, improvements in instrumentation, and secondly, a development in sampling technique by Hartley and Bennett in their integrating radiometer[24]. In the 'thirties, the various methods then in use were examined and serious discrepancies found. Arising out of this, the Gas Research Board has undertaken an investigation to ensure that all laboratories determining radiant efficiencies should show the same performance figure on the same appliance within reasonable limits. This work has progressed well and an acceptable thermopile method has been developed from the various methods already in use. At present this method and the integrating radiometer are being compared, and from the results of this comparison a final recommendation will be made.

Concerning radiation from the flame, the emission of the aerated town gas flame has been studied for all three ranges, infra-red, visible and ultra-violet, but there would seem to be less knowledge about the emission from a diffusion flame. The radiation from refractories, particularly in the infra-red range, is being investigated at Leeds.

As is well known, there has been little fundamental progress in gas lighting since the early years of this century. While the action of the Welsbach mantle can be explained in terms of the physical characteristics of its component materials, it is not known why these properties differ so markedly for various materials. If gas lighting is not regarded as a lost cause,

there are possibilities of technical advance, for instance, in the application of F.-centre phenomena, or of candoluminescence. Some of the possibilities have been given in greater detail by Minchin in a memorandum called 'Energy Efficiency of Gas Lighting'[26].

Corrosion

So far, some of the problems arising in gaseous combustion and heat transfer have been discussed. A further difficulty occurs in practice for an appliance may have a certain efficiency when tested new, but this may deteriorate in use. This may be due, for example, to the partial blocking by corrosion of the passages through which the combustion products flow during the heat transfer process.

This corrosion is the action of some of the products of combustion on materials in their path. A large part of the corrosion is due to the oxides of sulphur in the products of combustion, a lesser amount to the oxides of nitrogen while, of course, there is also some direct oxidation. It is known that the amount of corrosion may be decreased in two ways, either by the more complete removal of sulphur from the gas distributed, or by using for the construction of appliances materials which are highly resistant to this type of corrosion, such as the resistant steel developed by Radiation Ltd.[27] Both of these solutions to the corrosion problem have economic difficulties, so it is still necessary to understand fully the process occurring in order to be sure that these methods are the best available and to assist in the discovery of resistant materials.

The problem of corrosion may be conveniently divided into two parts—the mechanism of the formation of the corrosive substances in the combustion process, and the attack by these substances on various materials under the operating conditions of different types of appliances. Both of these processes have been investigated by workers in other fields, but their results on the whole are not applicable to the particular conditions in which the gas industry is interested.

The corrosion problem is particularly serious in heat exchangers, since in these the exposure of relatively large surface areas to the products of combustion is essential. Consequently the appliances most liable to be affected by corrosion are water heaters and the experimental work on corrosion reflects this. Most of this has had the aim of investigating the attack of the materials in appliances by combustion products. Some work at Leeds for the Joint Research Committee showed that the corrosion problem was more serious under condensing than non-condensing conditions[28]. Subsequently, a full scale investigation, using water heaters, by the South Metropolitan Gas Company, in co-operation with the Gas Research Board[29], showed that the amount of corrosion varied directly with the sulphur content of the gas, although at very low sulphur contents there were indications of some increase in corrosion, possibly due to oxides of nitrogen being effective under these conditions. Recently, Kerr and Withers (Nash and Thomson, Ltd.[30]) have published some interesting information on corrosion of solder-coated copper under conditions resembling the operating conditions of water heaters. These experiments showed the variation of corrosion with temperature and the importance of the 'acid-free' and 'acid' dewpoints in this respect. The Gas Research Board has developed a cyclic test technique whereby materials may be subjected to accelerated corrosion tests under conditions simulating those occurring in the operation of water heaters. This technique is now being applied to test the corrosion resistance of various coatings on copper under these circumstances.

Much less is known about the other side of the corrosion problem—that is the formation of the corrosive substances, which are the oxides of sulphur and nitrogen, the former playing a very much more serious part in causing corrosion than the latter. The major problem is, therefore, the study of the mechanism of formation of sulphur trioxide and sulphur dioxide in flames. The kinetics of the SO_2—SO_3 reaction has received little attention from the gas industry. This reaction has been investigated by many workers, but generally for conditions in flue gases when the sulphur content of the fuel is much greater than that of town gas. This work cannot, therefore, be directly applied to the conditions occurring in the combustion of town gas, nor can the experimental techniques be taken over without modification, since, on the whole, much greater sensitivity is needed. The amount of SO_3 present in the products of combustion affects the corrosion in two ways. First, the acid concentration in the dew deposited by the combustion products on a cool surface with which they come into contact varies directly with the SO_3 concentration in the gases and the corrosion caused will increase with the acid concentration, other conditions being the same. Secondly, the dewpoint of the products of combustion is elevated in the presence of SO_3 and this increases the temperature range during which condensation occurs. The mechanism of the formation of the oxides of sulphur in flames is now being investigated by the Gas Research Board. So far a satisfactory method of measuring both the dewpoint and the SO_3 content of combustion products has been developed. The effect of various factors on the SO_2/SO_3 ratio at known positions in the combustion region will now be investigated. The study of the formation of oxides of nitrogen in flames will be commenced as soon as possible.

Objectives of the Use of Gas

So far, some of the problems arising in the use of gas have been discussed. In addition, there remains a different class of problem, for, even with a perfect understanding and control of the processes of combustion, heat transfer and corrosion, it is still necessary to define the object to be attained before any particular use of gas can be made highly effective. That is, the conditions to be created by an appliance in order to be effective in any particular use must be known. These conditions vary with the application considered and in the industrial field it is probable that most problems have to be dealt with individually, but on the other hand, in this field it is usually possible to specify the required conditions. In the domestic field, however, these conditions cannot always be specified. This is particularly true of space heating and cooking.

There are two sides to the problem of space heating: the first concerns the design of buildings so that heat produced inside is used as economically as possible, and the second concerns the form in which the heat should be distributed to give the greatest human comfort; for a certain amount of heat introduced, how much should be convected and how much radiated? What wavelengths are best for radiated heat? It is not known for certain that there is an advantage in distributing part of the available heat by convection. Since radiant heat warms the surroundings and is thereby rapidly converted to convected heat, this advantage is not obvious. It would be interesting to see the results of tests carried out comparing the effectiveness in producing human comfort of the same amount of heat divided in various proportions between radiation and convection.

On the building side, the Building Research Station have undertaken a very comprehensive series of experiments on 28 houses at Abbots Langley[31]. In view of the large scale of this work and the many factors being considered, it will necessarily be some time before results become available. The first interim report appeared recently. Similar studies are needed for the differing conditions in large buildings for various types of use.

The subject of human comfort is very complex and, because of the human element, a statistical approach and treatment is required in its study. The value of some of the earlier work on this subject was reduced owing to a lack of appreciation of the statistical nature of the problem and a consequent use of unsatisfactory sampling techniques. The work of Professor Brunt[32], [33], of London University, Bedford[34], [35], of the Medical Research Council and that sponsored by the American Society of Heating and Ventilating Engineers may be mentioned among that which is elucidating the various controlling factors that determine human comfort under different conditions.

Among these factors are air temperature, temperature of

the surroundings, humidity, air velocity and temperature gradients. Various attempts have been made to devise scales of warmth which takes some or all of these factors into account. Four of these are of interest:—

1. *The Dry Kata Thermometer Cooling Power.* This is very sensitive to the effects of air movement, but its sensitivity renders it unreliable as an index of the effects of warmth on the human body.
2. *Effective Temperature.* This is widely used in North America and allows for the effects of air temperature, humidity and speed of air movement. It makes no specific allowance for radiation so that if the temperature of the surroundings differs sensibly from that of the air some correction is clearly necessary.
3. *Equivalent Temperature.* This is determined by an eupatheoscope and may be defined as that temperature of a uniform enclosure in which, in still air, a black body of sufficient size would lose heat at the same rate as in the environment, the surface temperature of the black body being one-third of the way between the temperature of the enclosure and 100°F.
4. *The Globe Thermometer.* This was introduced as a means of indicating the combined effects of radiation and convection as they affect the human body. The instrument is inadequate, however, when used over a range of wind speeds.

In view of the variations in individual assessments of comfort under the same conditions, and also of the variation in these conditions that are bound to occur in practice—for example the temperature and humidity of a room probably vary considerably during the course of a day—various attempts have been made to define the limits between which the factors affecting human comfort should be held. These have been called comfort zones, but no final agreement about these limits has yet been made.

So far reference has been made to environmental conditions as they affect comfort as determined by sensations of general bodily warmth. Further complexities arise when consideration is given to those factors which lead to feelings of freshness or stuffiness.

Bedford has summed up the requirements for a pleasant and invigorating indoor environment as:

(i) A room should be as cool as is compatible with comfort.

(ii) There should be adequate air movement, but no local draughts. At the temperatures commonly maintained in British buildings during cold weather air speeds much below 20 ft./min. tend to cause feelings of stuffiness, while distinctly higher speeds are desirable in warm weather.

(iii) The air movement should be variable, rather than uniform and monotonous.

(iv) The relative humidity of the air should not exceed 70% and should preferably be well below that figure.

(v) The mean temperature of the solid surroundings should preferably be above the air temperature.

(vi) The air at head level should not be distinctly warmer than that near the floor and the heads of the occupants should not be exposed to excessive radiant heat.

In the use of gas for cooking, development has been mainly guided by extensive surveys of consumer requirements. Without detracting from the value of these there is also scope for more investigations of the physics and chemistry of cooking processes. The possibilities are illustrated by the development of pressure cookers.

Conclusion

With the limitations of available time, it has only been possible to mention a selection of the research problems in the use of gas. The selection made naturally reflects the author's opinion of those problems which are most important. It would be of great assistance to the work of the Gas Research Board if it proves possible to gauge, from a discussion of this paper, the relative importance to the industry of the problems mentioned, and others which will no doubt be suggested.

In this survey of problems in the use of gas, many gaps in our fundamental knowledge have been indicated. This should be a source of optimism about the future, for, as the gas industry has reached its present position with this incomplete knowledge, then it can surely be expected that considerable progress will be made as these gaps are filled.

The above photograph shows members of the Southern District (Sussex Area) Circle during a visit to Electrolux, Ltd., on May 2. Included in the group are Mr. H. C. Collins, Chairman, Mr. L. S. Sopp, Secretary of the Circle, and Mr. S. L. Woodcock, Gas Liaison Manager for Electrolux, Ltd.